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Haec Credimus

For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested on the seventh.—Exodus 20:11

What Triggered the Flood?

Walt Brown*

Abstract

Sometime after the Fall but before the Flood, God set in motion a chain of physical events that produced a global Flood. Although we cannot be sure exactly how it began, that cataclysm had many consequences: layered fossils; coal, oil, and methane deposits; major mountain ranges; ice ages; and dozens of other global features. Our challenge is to show how all these are related and are consistent with the laws of physics and the biblical account. Recognizing that water was created under the earth's crust and understanding the second creation day clarify the Flood considerably and explain many major issues that befuddle evolutionists.

Introduction

God initiated the Flood as a result of man's sin. At the end of the creation week, all that God created was "very good" (Genesis 1:31), so the Flood was not inevitable at that time. In other words, the earth was not created with a "ticking time bomb." Nor was the universe created with killer comets, asteroids, or meteoroids aimed at earth. Indeed, their presence at the end of the creation week would not have been "very good." (The origin of comets, asteroids, and meteoroids—consequences of the Flood—are proposed in Brown, 2001, pp. 188–225.)

Later, because of the depth of man's sin (Genesis 6:5–6), God flooded the entire earth. We may never know just how the physical chain of events for the Flood began, but the Bible gives some intriguing clues.

A summary of the hydroplate theory (Brown, 2001, pp. 86–119) shows how a global Flood, corresponding in every detail to the Genesis Flood, easily explains 25 otherwise mysterious features of the earth and solar system. This theory requires two starting conditions: (1) a large volume of salty water contained in interconnected subterranean chambers, and (2) steadily increasing pressure in that subterranean water—enough to rupture the earth's crust. Although the Bible speaks in several places of considerable subterranean water (Brown, 2001, p. 257), why would its pressure increase sufficiently to form a globe-encircling crack in the earth's crust?

Rock Movement

First, visualize an important feature of the newly created, preFlood earth. Imagine the entire earth's surface covered by a sandwich arrangement in which a horizontal layer of rock (which will become the earth's crust) has a layer of water above and also below it. The rock layer is almost 10-miles thick; each water layer is about ¾ of a mile thick. The water above this rock layer is surface water; the confined water below is subterranean water. If the rock layer were perfectly uniform in thickness and density, everything would be in balance. Equilibrium would exist.

No doubt variations existed in the rock's thickness and density. The heavier parts would sag (bend) downward, like an overloaded floor, causing additional water on top to flow into each depression. That added weight would increase each sag. More surface water would flow into the growing depressions, driving each sag even deeper. The rock layer would have had some stiffness, because it was almost 10-miles thick. However, the plate's large area (basically the surface of the earth) would have given it an area-to-thickness ratio of about 20 million to one! This would be similar to a paper-thin sheet of tin, steel, or rock, 25 feet on each side. Consider its flexibility and how quickly it would sag downward just one-tenth of its thickness.

The effects of the rock sagging downward through water at one location on earth would spread laterally, but only at the speed of sound. Outside that expanding "ring of influence," other sags could occur simultaneously.

Some of the sagging rock would also be squeezed downward through the subterranean water, forming protrusions—or "pillars"—pressed against the chamber floor. This would happen because the rock's pressure at the bottom of the rock layer's thicker, denser portions would exceed the subterranean water's pressure pushing upward. If the pressure difference exceeded the rock's shear strength at that point, rock would "flow" downward, deforming like putty. High confining pressures would not allow cracks to

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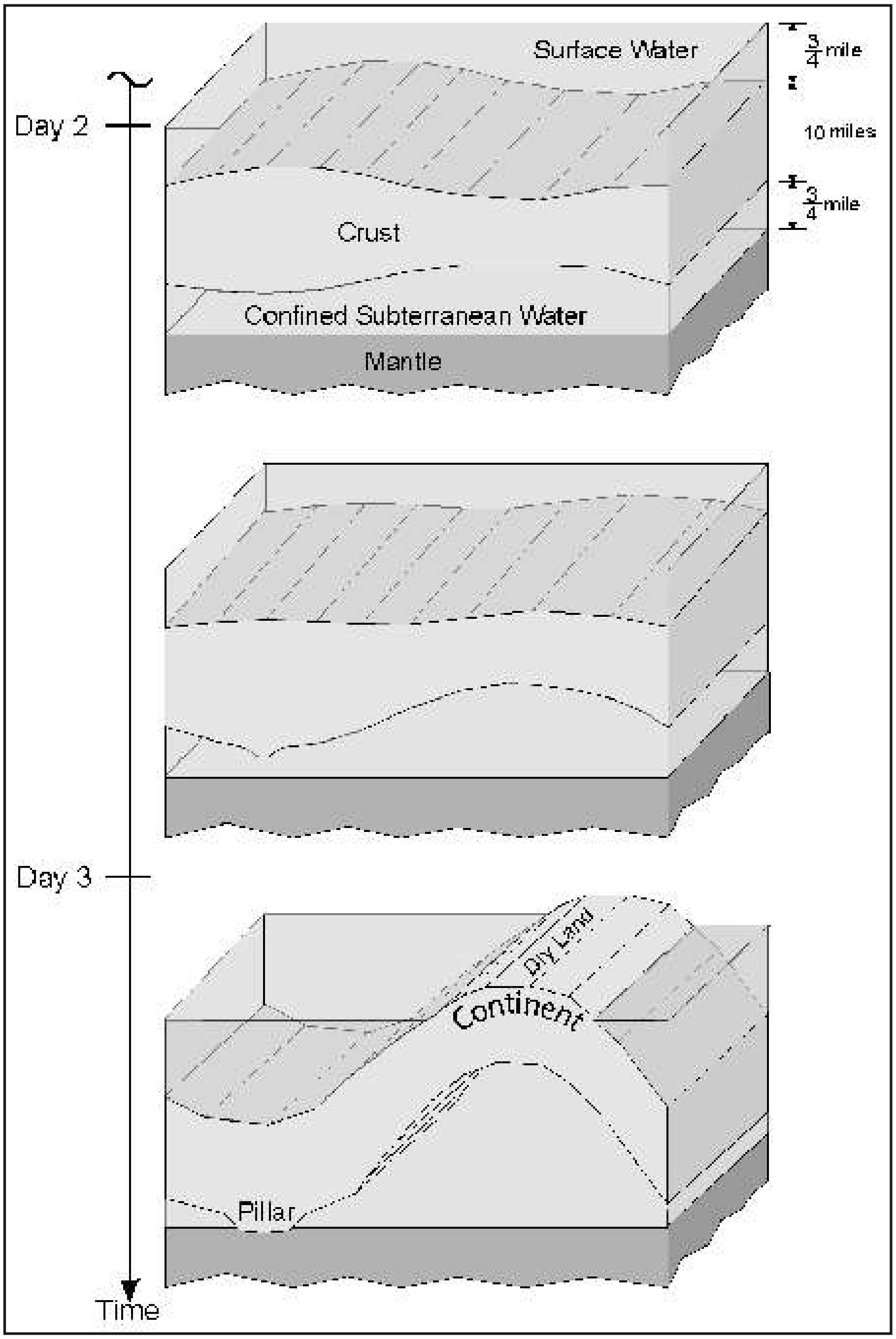

Figure 1. Dry Land Appears. At the end of the first creation day, Day 1, water covered the entire earth. On Day 2, God made a “raqia” that sharply separated (“badal”) the liquid water (“mayim”) above from the liquid water below. On Day 3, land rose out of the surface water, in preparation for the creation of plants, animals, and humans. (Water thicknesses are exaggerated to illustrate events of Days 2 and 3. Dimensions are estimates.)

open or rocks to break, as occurs with brittle material at the earth’s surface. Compression tests on cylinders of rock subjected to high confining pressures, but larger axial loads, show that the rock cylinders deform like putty.

Downward protrusions (pillars) would grow like the downward flow in a lava lamp, except the rock, being a solid instead of a liquid, had internal strength due to atomic bonding. The deeper the pillars went, the greater this pressure difference would become, so rock would “flow” even deeper until all pillars pressed against the chamber floor. Pillars carrying an excessive load would thicken and penetrate slightly into the chamber floor.

The same effects, but in the opposite direction, would have lifted thinner, less-dense portions of the rock layer up out of the water, forming continents. Keep in mind that the confined subterranean water had essentially a fixed volume. Therefore, as rock sagged downward and as pillars were squeezed downward, this fixed volume of subterranean water had to displace thinner parts of the rock layer, forcing them upward.

If, on Day 2 of the creation week, our “sandwich” encircled the earth like the outer three rings of an onion, water would cover the entire earth. In the following hours, the thinner rock would rise out of the surface water and become dry land. Water would drain into depressions. This seems to be what happened on Day 3 (Genesis 1:9–10). Water covered the entire earth, then “God said, ‘Let the waters below the heavens be gathered into one place, and let the dry land appear’; and it was so. And God called the dry land earth, and the gathering of the waters He called seas;” (Further support for this interpretation of Day 2 is given in Brown, 2001, pp. 260–268.)

Genesis 1:9 says the waters below the heavens were gathered into one place (i.e., one big ocean). Why, then, in the next verse did God call the collected waters “seas”—plural? Answer: Multiple seas were honeycombed below the crust. *The Interpreter’s Bible* explains:

> “Seas” embraces more than the waters upon the face of the earth; it includes also the (supposed) subterranean waters upon which the earth was believed to rest … and the circumfluent ocean, upon which the pillars of the firmament stood (Bowie, 1952, p. 473).

Psalm 24:2a specifically states that God “founded it [the earth] upon the seas.” Recognizing that a large amount of water was under the preFlood crust, as the Bible also states in Psalms 33:7, 104:3, and 136:6, is essential to understanding the Flood. Our failure to understand basic physical aspects of the Flood opened the door to evolution and a belief, by some, in a multibillion-year-old earth.

Interestingly, Day 2 was the only creation day in which the Bible does not expressly say God saw that day's work was "good." Certainly, nothing bad was done on the second day, because at the end of the creation week, God saw that all He had made was "very good." Apparently, the second day's activity was not completed until Day 3.

Now we can see why. On Day 2, after the crust was created with liquid water above and below it, the crust began to deform. Thicker portions sagged and squeezed down pillars, while thinner portions rose out of the water. Thus, Psalm 104:3, in describing Day 2—the connection of Psalm 104:3 with Day 2 is made clear by Keil and Delitzsch (1981, p. 128)—states (with my interpretations in brackets), "He lays the beams [pillars] of His upper chambers [the crust] in the [subterranean] waters." By Day 3, surface water had drained into depressions, forming dry land—a "good" condition (Genesis 1:10) necessary for the life God would create next.

Peter also seems to describe these events in II Peter 3:3–6. He states that in the latter days mockers will not understand that, "the earth was formed out of water and by water, through which the world at that time was destroyed, being flooded with water."

This is consistent with the following interpretation: On Day 2, a nearly horizontal crust, or "expanse," was formed in the midst of the liquid water covering the earth (Genesis 1:2,6,7,9). On Day 3, thinner portions of the crust rose out of the water, causing water above the crust to flow into depressions (Genesis 1:10). In other words, the earth (its crust) was formed *out of* (rose out of) surface water and was formed *by* pressure from subterranean water. Some might incorrectly think "forming the earth out of water" implies alchemy—water (H_2O) was changed into SiO_2, $(Mg,Fe)_2SiO_4$, and a host of other minerals that comprise rock. Actually, "out of" is used in a spatial sense. The King James translation conveys this idea more clearly: "… the earth standing out of the water … ."

Almost 2,000 years later,[1] the water below the crust burst forth as "the fountains of the great deep," combined with the surface water, and, as Peter wrote, flooded and destroyed earth in a global cataclysm. The Greek word "katakluzo," from which we get our word "cataclysm," is translated as "flooded" in II Peter 3:6. In describing Noah's Flood, the Bible never uses the normal Greek or Hebrew words for flood. Noah's Flood was much more; it was an unparalleled, global cataclysm.

The complex Hebrew word "raqia" is usually translated in modern times as "expanse" or "firmament." Raqia is sometimes identified with "heavens" but in other contexts refers to earth's preFlood crust (Brown, 2001, pp. 260–268).

Rock Pillars

Compressed subterranean water supported most of the crust's weight;[2] pillars supported the rest. Every 12 hours, tidal effects, caused primarily by the Moon's gravity, lifted the subsurface water (and, therefore, the earth's crust) a few feet, just as tides lift ocean surfaces today. At low tides, the crust settled. Therefore, the pressure each pillar exerted on the chamber floor increased and decreased twice daily. These loose, or flexible, contacts could be described as "sockets." Tides also occur in the solid earth (Brown, 2001, p. 306).

The Bible says the earth was founded on pillars. Psalm 75:3b says, "It is I [God] Who have firmly set its [the earth's] pillars." In Job 38, God demonstrates His authority by giving Job the most difficult science examination of all time. In verses 4–6, God asks Job, "Where were you when I laid the foundation of the earth! Tell Me, if you have understanding, … On what were its bases sunk?" This word, "bases," is translated in all 54 other places in the Bible as "pedestals" or "sockets," which held pillars.

Ancient extrabiblical writings, although not having the authority of biblical passages, also describe this structure within the subterranean water. As one example, the British Museum's *The Book of the Cave of Treasures* (1927), dated at about 300–599 A.D., states:

> And on the Third Day God commanded the waters that were below the firmament to be gathered together in one place, and the dry land to appear. And when the covering of water had been rolled up from the face of the earth, the earth showed itself to be in an *unsettled and unstable state*, that is to say, it was of a damp or moist and *yielding nature. And the waters*

---

[1] According to the Masoretic text of the Old Testament, this time period was 1,656 years. (Brown, 2001, p. 272)

[2] Some have asked, "How could rock float on water?" The crust did not float on water; water was trapped and sealed under the crust. It was like a thin slab of rock resting on and covering an entire waterbed. As long as the water mattress does not rupture, a dense slab will rest on top of less-dense water. Unlike a waterbed's seal, which is only a thin sheet of rubber, the chamber's seal was compressed rock almost 10-miles thick. Pressures in the crust 5 miles or more below the earth's surface are so great that the rock, if not rigidly contained, will flow like highly compressed, extremely stiff putty. The slightest crack or opening, even around a small chunk of rock, could not open from below.

> *were gathered together into seas that were under the earth and within it*, and upon it. And God made the earth from below, *corridors and shafts, and channels for the passage of the waters*; … Now, as for the earth, *the lower part of it is like unto a thick sponge, for it resteth on the waters*. [emphasis added]

The Bible often speaks of "the foundation(s) of the earth." On Day 3, the earth's crust was literally established, or set, on its foundation. Only by understanding some basic physics and the role of subterranean water, will this—and the Flood—be clear.

When the earth's crust ruptured *on one day*, the Flood began (Genesis 7:11). Water from the fountains of the great deep fell as rain. Subterranean water flowed with unimaginable force horizontally through the subterranean chambers and up through the rupture. Pillars were crushed into fragments by the increasing crustal loads they carried. Each pillar's collapse generated huge waves in the surface water and pressure pulses in the subterranean water. Rock fragments, accelerated into space by astounding energy sources in the fountains of the great deep, became meteoroids (Brown, 2001, pp. 188–225). Thus, the pillars or "foundations of the world" were "laid bare." This may be what Psalm 18:15 refers to when it says, "Then the channels of water appeared, and the foundations of the world were laid bare."

Rupture Mechanisms

But why might the pressure in the subterranean water increase enough to rupture the crust? Tides. Each "tidal lift" transferred energy from the Moon to the crust. As the massive crust settled between lifts, most of that enormous energy[3]was converted by friction into heat. For almost 2,000 years, cyclic compression of pillars and viscous movement of subterranean water generated heat, expanding the subterranean water's volume and increasing its pressure in the confined chamber. While some heat was conducted up into the crust and down through the subterranean chamber floor, it is difficult to calculate just how much. Nevertheless, almost 2,000 years of slow thermal expansion of the subterranean water could easily have increased its pressure enough to rupture the crust. (For a small rise in temperature, cool liquid water expands about ten times more than rock. Water's expansion rate, relative and absolute, is even greater as temperatures increase.)

If, as estimates indicate, thermal expansion from tidal heating ruptured the crust, the hydroplate theory's two starting conditions are reduced to one: the presence of a large volume of salty, subterranean water. The Bible speaks clearly of preFlood, subterranean water. (Brown, 2001, p. 257)

How hot might the high pressure water have become? Mineral structures in meteorites show that most were at one time at least 750°F, a fact that perplexes meteorite experts. Two common mineral structures in meteorites show that they were once very hot—iron meteorites, once 1,300°F and chondrules, once about 3,000°F (Brown, 2001, pp. 222–223). Also, the matrix material encasing chondrules shows thermal metamorphism requiring temperatures of at least 750°F (Norton, 2002, p. 92). While the heat-generating mechanisms for each are different, all three would heat pillars using gravitational potential energy. This heating throughout meteorites occurred before they were launched into supercold space, where temperatures are almost absolute zero, -460°F. (Heating due to impacts, launch, or reentry would not be throughout the meteorites.) If meteorites came from the subterranean chamber, the subterranean water was extremely hot.

Would such hot, erupting water kill all life, including life on Noah's Ark? Not necessarily. It depends on how much subterranean water escaped and where the Ark and various sea creatures were relative to the rupture and hot water currents. Today, the rupture is marked by the Mid-Oceanic Ridge that encircles the earth like the seam of a baseball. At the time of the Flood, about 60% of the earth's surface would have been at least 1,000 miles from the rupture. Certainly, in those regions the Ark and its cargo would have been relatively safe. In addition, water escaping from the subterranean chamber would rapidly cool as its pressure quickly dropped and as explosive evaporation, then mixing, occurred.

Sinking Continents

All subterranean water did not have to escape to Flood the entire earth. Remember, the thinner (and higher) portions of the crust were supported entirely by subterranean water, so as that water escaped, primarily the continents sank. Therefore, *the flooded earth resulted as much from sinking continents as from rising water*.

Genesis 7:20 says that the Flood waters covered all preFlood mountains by 15 cubits (about 22½ feet). Today, mountain heights vary by thousands of feet, so why did many, if not all, preFlood mountains have about the same elevation? (Some commentators, adding words not in the Bible, have said that "at least" 15 cubits of water were above all the earth's mountains. Others have said that the text means the Ark, whose height was 30 cubits, must have been only half submerged and did not run into mountain peaks.) The explanation becomes clear if we recognize that the earth was founded on and spread out above waters (Psalms 24:2, 104:3, and 136:6).

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[3] The energy added to the earth's crust every 12 hours by the gravitational pull of the Moon, and to a lesser extent the Sun, is proportional to the crust's weight times the average lift distance. While the lift distance is small, the mass lifted before the Flood was so gigantic that the total energy was huge. Most of this energy became heat inside the subterranean chamber as the crust settled between lifts. Today, ocean tides have comparable lift, but only a relatively insignificant mass is lifted.

On Day 3 of the creation week, the higher a continent rose out of the water, the more pressure it exerted on the subterranean water directly below. Therefore, as the land rose higher, it would have risen more slowly, giving pre-Flood mountains similar heights. (To demonstrate this buoyancy effect, support a large rock under water with one hand. Notice how the pressure on your hand increases as you lift the rock out of the water.)

Almost 2,000 years later, as the Flood waters rose and continents sank, another effect equalized mountain elevations even more. To visualize that effect, place the finger tips of your hand on a table. Now slowly push the palm of that hand (representing a sinking continent) toward the table (representing the subterranean chamber floor). Notice how the finger tips (representing pillars) in contact with the table must slide away from each other. Now imagine many hands with their finger tips resting on a large globe, but with each finger tip connected to one or more finger tips of an adjacent hand. If one palm were pushed down with greater force because it was higher than all others, its finger tips would push outward against the fingers of all adjacent hands, pushing their palms up. Likewise, the greater pressure exerted by higher, thereby less buoyant, mountains would tend to lift lower mountains, further equalizing their heights above the rising water—just as Genesis 7:20 states.

As the first days and weeks of the Flood passed, more and more of the crust rested on the subterranean chamber floor, increasingly restricting the water's escape. The vertical walls on each side of the rupture were almost 10 miles high. Because the rock's pressure in the bottom half of each wall exceeded its crushing strength, the unsupported, unconfined walls continually crumbled—for 150 days (Genesis 7:28). During that time, the upward-jetting, supersonic fountains of the great deep removed that rubble, widening the rupture hundreds of miles, like falling dominoes, all around the earth.

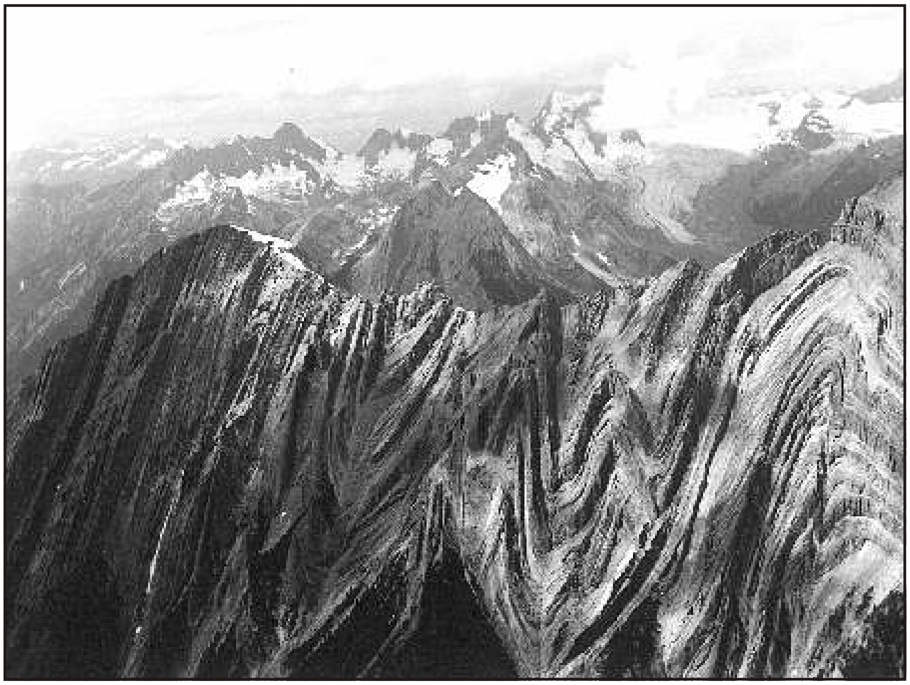

Figure 2. A buckled mountain is exposed here along the Sullivan River in British Columbia, Canada. (Photograph courtesy of the Geological Society of Canada, number GSC 180345.) Obviously, these layers were soft, like wet sand, at the time of compression. Today, surface rocks are brittle. Standard explanations for buckled mountains, and mountain formation in general, are seriously flawed (Brown, 2001, p. 311).

Mass deep in the mantle shifted slightly toward these relatively unloaded portions of the chamber floor. Suddenly, the chamber floor buckled upward beneath the widened rupture, first forming the Mid-Atlantic portion of the Mid-Oceanic Ridge. The crust slid on lubricating water, downhill and away from that Atlantic-Ridge segment. Sliding continental plates—the hydroplates—crashed and compressed, in what is called the "compression event."

Weaker portions of the hydroplates crushed, thickened, and buckled. In doing so, new postFlood continents rose out of the Flood waters, allowing water to drain into newly opened ocean basins. Buckled mountains also formed, as shown in Figure 2. For each cubic mile of land that rose out of the Flood waters, one cubic mile of Flood water could drain. (Note: today the volume of all land above sea level is only one-tenth the volume of water on earth.) Other dramatic consequences in the Pacific, including formation of gigantic oceanic trenches, are discussed in Brown, 2001, pp. 120–137.

Sliding rock-on-rock contacts quickly became molten rock-water mixtures. This explains why magma contains a surprising amount of dissolved water, why a thin saltwater layer appears to be under all continents at the depth predicted by the hydroplate theory[4], and why a thick layer of water appears to be under the Tibetan Plateau.[5]

Other Questions

For centuries, hundreds of sincere questions concerning the Flood have been asked; they deserve thoughtful answers. Without clear answers, a "vacuum" has existed into which evolutionists have placed faulty theories. Telling nonbelievers to simply believe the Bible accomplishes little. While some may feel this is a proper response, it usually angers nonbelievers unnecessarily.

One philosophical question, partially answered in the introduction, lurks in the background: "Was the Flood 'programmed' from the beginning?" In my opinion, the answer is, "no." Sin has physical consequences (Genesis 3). What might they be when every intent of all humans except Noah was evil continuously (Genesis 6:5, 7:1)? Man's sin might have directly caused any of a million physical changes within the earth that either (1) allowed the subterranean water's pressure to exceed a high threshold and rupture the crust or (2) produced a flaw, such as a unique microscopic crack, at the earth's surface.

Of course, God could simply have commanded the earth's crust to crack after the subterranean pressure had risen. God spoke the universe into existence, so commanding a microscopic crack to form at the right place—which is all it would take—is not difficult to imagine.

Conclusion

Day 2—a key to explaining the Flood—has been poorly understood. As Peter wrote, people would not understand that earth's crust was formed out of and by water which later flooded the earth. This proposed interpretation of Day 2 helps us appreciate the presence of so much subterranean water, the power of "the fountains of the great deep," why they erupted so quickly (on one day), and where the Flood waters came from and where they went. Had the Flood been better understood before Charles Darwin popularized evolution, that "idea vacuum" would never have formed, and many more would have recognized evolutionary explanations as obviously inferior. Evolution would not have flourished. Our task, then, is to fill this "vacuum" by explaining to others what we now know about the Flood.

References

Book of the cave of treasures. 1927. Translated from the Syriac Text of the British Museum (MS. Add. 25875) by Sir E. A. Wallis Budge. The Religious Tract Society, London, England.

Bowie, Walter Russell. 1952. The book of Genesis. *The interpreter's bible*, Volume 1. Abingdon Press, New York.

Brown, Walt. 2001. *In the beginning: compelling evidence for Creation and the Flood*, seventh edition. Center for Scientific Creation, Phoenix, AZ. (This book can also be read on the internet at www.creationscience.com in English, French, German, Spanish, Chinese, Japanese, Korean, Italian, and Protuguese. Page numbers in the web version of the book differ from those referenced in this article.)

Hyndman, R. D., L. L. Vanyan, G. Marquis, and L. K. Law, 1993. The origin of electrically conductive lower continental crust: saline water or graphite? *Physics of the Earth and Planetary Interiors* 81:325–344.

Keil, C. F. and F. Delitzsch. 1981. *Commentary on the Old Testament*, Volume 5. Eerdmans Publishing Co., Grand Rapids, MI.

Norton, Richard O. 2002. *The Cambridge encyclopedia of meteorites*. Cambridge University Press, Cambridge, England.

Wei, Wenbo, Martyn Unsworth, Alan Jones, John Booker, Handong Tan, Doug Nelson, Leshou Chen, Shenghui Li, Kurt Solon, Paul Bedrosian, Sheng Jin, Ming Deng,

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[4] "Magnetotelluric measurements show the lower continental crust to be electrically conductive globally … The most probable candidates for the conduction mechanisms are small amounts of interconnected saline pore fluids and interconnected thin films of graphite. … We favor the supercritical saline fluid model … . " (Hyndman et al., 1993, pp. 325–344)

While these authors favor the saltwater explanation for this electrical conductivity, they visualize this salt water contained in so many microscopic pockets that they are electrically connected horizontally. This puzzles the authors, because with so much horizontal connectivity, they reason there should also be vertical connectivity. Over long geological ages, this water should have leaked up to the earth's surface.

The hydroplate theory resolves this problem. The saltwater layer began with worldwide connectivity. High compression in the rock immediately above the subterranean water allowed no vertical porosity. The subterranean water layer simply became thinner as water escaped during the Flood.

[5] "A layer of aqueous fluids could produce the conductance observed in Tibet with a lower fluid fraction and/or layer thickness than considered above for partial melt. For example, a layer only 1.6 km thick containing 10% of 100 S/m brine would be needed to yield the observed 10,000-S conductance." (Wei et al., 2001, pp. 716–718.)

The hydroplate theory makes 34 explicit predictions. This prediction that large volumes of pooled salt water are beneath major mountains was first made in 1980. Salt water appears to be about 10 miles below the Tibetan Plateau, which is surrounded by the largest mountain range on earth.

Juanjo Ledo, David Kay, and Brian Roberts, 2001. Detection of widespread fluids in the Tibetan crust by magnetotelluric studies. *Science* 292:716–718.

Note: This article will appear in the eighth edition of *In the Beginning: Compelling Evidence for Creation and the Flood*. Center for Scientific Creation, Phoenix, AZ.

Book Review

The Right Questions: Truth, Meaning, and Public Debate by Phillip E. Johnson
InterVarsity Press, Downers Grove, IL. 2002, 191 pages, $16

The modern intelligent design (ID) movement began in 1991 with the publication of *Darwin on Trial* by a then-obscure Berkeley law professor, Dr. Phillip Johnson. The ID movement and Johnson have come a long way since then. The idea that life originated from an intelligent cause has become respectable once again, and Darwinian evolution is receiving strong challenges on many fronts.

Before Johnson started his work, creationists of various persuasions fought with each other over such issues as the age of the earth, Flood geology, and the meaning of the fossil record. While these issues are important, Johnson argued that these are not the key questions with regard to public debate. Johnson launched a new strategy; it might be called "unite and win" (p. 9).

What Johnson did was to ask the right questions: "Is nature all there is? Can natural forces alone explain the universe and everything in it? Did life arise by blind, materialistic Darwinian processes, or does the evidence point to other forces?" (p. 9) Christians may argue about *how* God created, but they all agree that the universe is the work of a personal, all-powerful God. The beauty of Phillip Johnson's approach is that it has the ability to unite Christians across a broad spectrum. Indeed, many believe the ID movement has largely achieved this goal, and naturalistic philosophy is feeling intense pressure as a result.

This latest book by Phillip Johnson is considerably different from his earlier works, which concentrated on the logic and science associated with the Darwinian evolution vs. intelligent design controversy. *The Right Questions* is an intensely personal account in which Johnson talks more about his personal faith and less about evolution and design.

Johnson spends a fair amount of time discussing how science is defined, a fundamental question in the evolution/design debate. Is science limited to exploring *natural* explanations for natural phenomena, or should *all logical* explanations (naturalistic or not) be considered?

In today's world "a credulous public is taught to accept philosophical naturalism/materialism as inherent in the definition of science" (p. 33). *Naturalism* is the philosophy that nature is all there is. That is, it's the belief that there is no supernatural aspect to existence. Naturalism says that everything can be explained by the laws of chemistry, physics, and random chance.

At the same time, however, modern discoveries in biochemistry and other branches of science are providing new compelling evidence that nature is *not* all there is to reality. The discoveries that DNA has a complex *code* (information), and that many biological systems have the property of "specified complexity" provide strong support for the intelligent design of life.

Nevertheless, the science establishment, due to its naturalistic bias, continues to suppress and dismiss this compelling evidence. Johnson says that most people "instinctively recognize that a supernatural intelligence must be at work in the wonder of biology. It takes years of indoctrination to learn to ignore the evidence of intelligent design that is so apparent before our very eyes" (p. 35).

Interestingly, while the science establishment holds fast to its naturalistic philosophy, most Americans aren't buying it. For example, a *Cleveland Plain Dealer* poll (May 2002) found that only 8 percent of Ohioans accept naturalistic evolution as the best explanation for the origin and development of life. Most of the rest believe that an intelligent cause was involved.

The debate between evolution and design/creation usually focuses on the first chapter of Genesis: "In the beginning God created…." Johnson says it is time to focus instead on the first chapter of John: "In the beginning was the Word…." The Word (God) implies *information* and *intelligence*. Johnson argues that "the evidence of science shows that 'in the beginning was the Word' is as true scientifically as it is true theologically, spiritually and in every other way" (p. 141).

In July of 2001 Dr. Johnson suffered a debilitating stroke that hampered him physically, but his mind remained sharp and focused. In the process of his recovery, Johnson's faith in God was strengthened and entered a new dimension. His newly found, deeper trust in God is reflected in *The Right Questions*. Phillip Johnson has been asking (and answering) the right questions for a dozen years now, and in the process he has transformed the evolution/design debate in ways that will have repercussions for years to come.

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The Evaporite Deposits of Saltville, Virginia

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Abstract

Suggestions by various authors for the origin of evaporite deposits in the Saltville, Virginia region are reviewed. Past tectonic activity and its effects on the evaporites are discussed. The geologic setting of the area is noted, and the mining and manufacturing history in Smyth and Washington counties in relation to the evaporite deposits is briefly described. A preliminary young earth-Flood model for evaporite formation and subsequent tectonism is presented.

Introduction

As you drive into the small, picturesque town of Saltville in southwestern Virginia you are greeted by the sign (Figure 1), Welcome to Scenic Saltville: Salt Capital of the Confederacy. Toward the end of the War Between the States, the facilities in this Smyth County town (Figure 2) produced most of the salt consumed by the Confederacy. Approximately 200 million pounds of salt were produced in Saltville during 1864 (Whisonant, 1996, p. 21). The salt was removed from wells in the Saltville Valley which is underlain by the Mississippian Maccrady Formation containing red, green and gray shales, siltstone, limestone, dolostone, and evaporite deposits (halite [NaCl], anhydrite [$CaSO_4$] and gypsum [$CaSO_4 \cdot 2H_2 0$]). The various suggested mechanisms of formation of the evaporites will be presented including an origin of the minerals based on a Flood, young-earth model.

Figure 1. Sign at town limits of Saltville, Virginia.

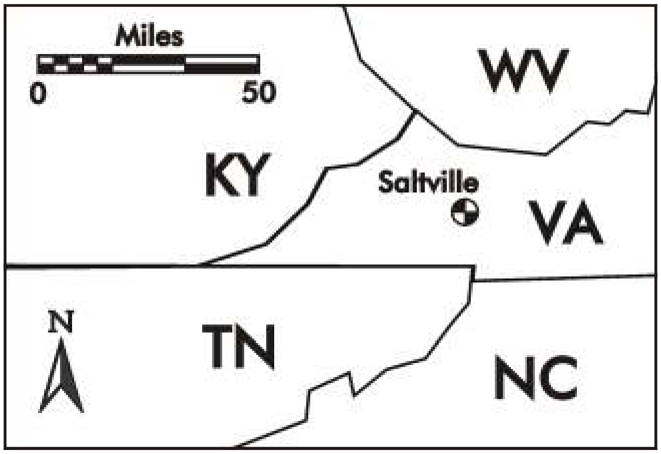

Figure 2. Location of Saltville in southwestern Virginia.

Salt and Gypsum Production in Saltville Valley: History and Aftermath

In the colonial era, around the 1750s, Charles Campbell obtained a patent for the land containing most of the saline ponds and springs in the valley from King George II. After the death of Campbell, the grant went to his only son, William, who, during the Revolution, commanded Colonial forces at Kings Mountain and won the battle against Loyalists led by Major Patrick Ferguson. Many of the men who fought with Campbell were from southwest Virginia and participated in the overmountain march to Kings Mountain. It is ironic that these men are referred to as Patriots, whereas less than 100 years later, the Southern men who attempted to defend their homeland are called Rebels. It depends on who wins the war!

The first known commercial development of salt was initiated in 1782 by Arthur Campbell, a cousin of William.

These early salt works of the late 1700s consisted of wells from which the brine was drawn, furnaces in open sheds in which saline waters were boiled in [8

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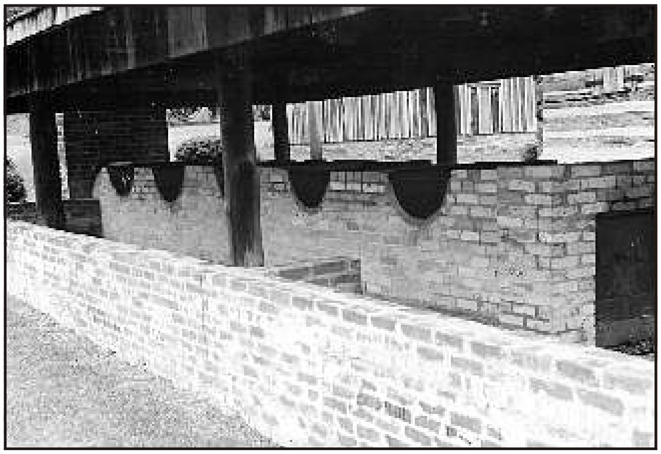

Figure 3. Replica of salt furnaces with kettles in which brine solutions were evaporated, Saltville, Virginia.

> to 12-gallon] kettles, and salt houses where salt was stored... (Whisonant, 1996, p. 25). [Brackets added.]

William King, who owned land adjacent to the Campbells, dug a mine shaft 200 feet downward into the Maccrady which almost filled with water. Therefore, he produced salt by the well and furnace method also. King was obtaining 200 bushels of salt per day by 1800.

Watson (1909, p. 119) claimed that the earliest borings for salt in the valley "...were in the old swampy lake-covered area near the present site of the town of Saltville." In 1840, a mine shaft 210 feet deep struck a bed of rock salt. But the mining of salt was never attempted, the mineral was always recovered from the salt brines in the wells. Reproductions of the salt furnaces with kettles and walking beam brine pumps to pump the saline solution to the surface can be seen at a Park located along Route 91near the southern town limit of Saltville (Figures 3 and 4). The importance of Saltville during the War for Southern Independence and the battles fought over control of the town are covered in the excellent article by Whisonant (1996) along with a discussion of the geology of the area.

Two of the major salt operations were sold to the Mathieson Alkali Works which was chartered in 1892 and began salt production at Saltville in 1895 (Sharpe, 1985, p. 42; Craig, 1973, p. 7). The company continued to mine salt in the "old well field" until around 1930 (the deepest well being 2380 feet) when a high pressure well field was placed in operation with wells over 4000 feet in depth (Cooper, 1966, p. 28). By 1906, Mathieson had ceased salt manufacture and concentrated on producing salt by-products (Whisonant, 1996, p. 28). According to Cooper (1966, pp. 28, 29):

> The Mathieson Chemical Corporation merged with Olin Industries in 1954. Olin Mathieson produces gaseous and liquid chlorine, soda ash, technical carbonate, and ammonia soda by processing brine. Limestone mined in Rich Valley is transported to Saltville by aerial tram [Figure 5] and is calcined to lime which is used in production of alkali. The carbon dioxide derived from calcination is recovered and processed into liquid carbon dioxide and Dry Ice. Hydrazine is also produced at Saltville. [Brackets added.]

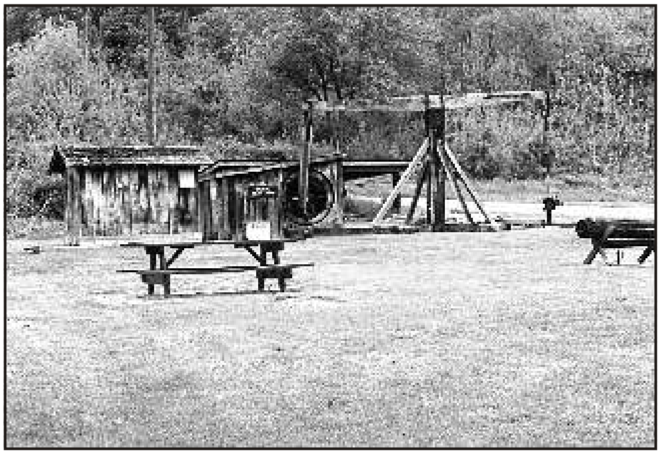

Figure 4. Replica of walking beam brine pump which was used to draw brine solutions from below the ground, Saltville, Virginia.

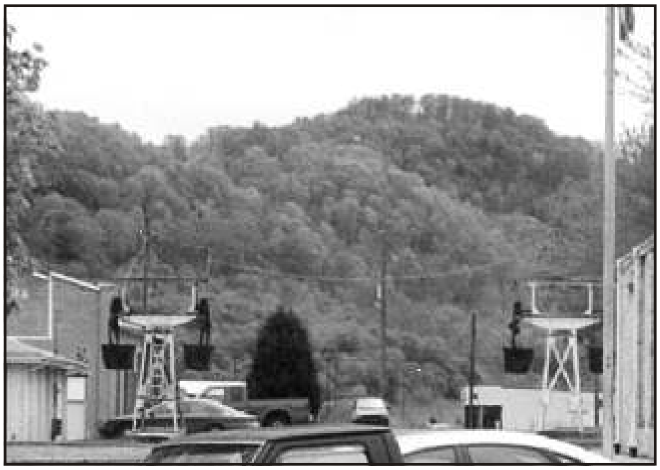

Figure 5. A portion of the former aerial tram can be seen beyond the post office in Saltville, Virginia.

All manufacturing and brine production ceased in Salt–ville in the early 1970s. Salty ponds still dot the floor of the valley (Figure 6). The movement of salt to the surface "...created the only salt marsh habitat in the western area of Virginia" (Ogle, 1999, p. 2). About 20 percent of the valley is covered with standing water (McDonald, 2000, p. 10).

Gypsum was found in the Maccrady and mined near Plasterco (Figure 7) as early as 1815 (Cooper, 1966, p. 29). The Buena Vista Plaster Co. operated mines, quarries and a calcining plant in Plasterco in the late 1800s to the early 1900s. The United States Gypsum Co. leased the Buena Vista facilities in 1909, and purchased them in the 1920s (Sharpe, 1985, p. 41). "The No. 6 mine [at Plasterco] was operated from 1911 to 1979 and was the

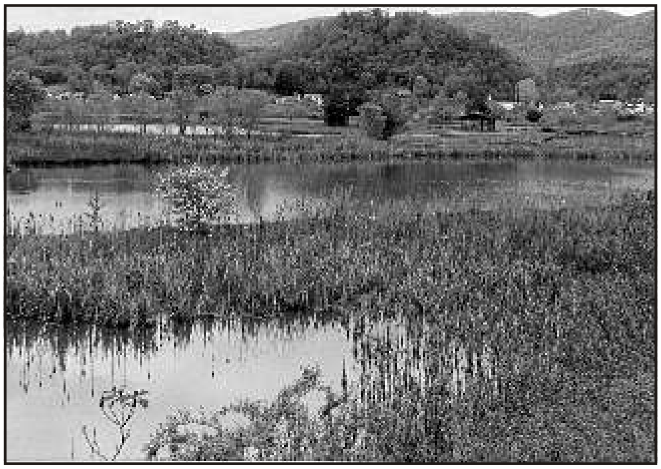

Figure 6. Some of the many salt ponds that dot the landscape in Saltville, Virginia, creating a salt marsh environment. Note highlands in the background.

deepest gypsum mine in the world" (Sharpe, 1985, p. 41) at that time [Brackets added]. At first during the 1800s, gypsum was sold strictly for agricultural purposes, then later for wallboard products also. Several mining operations for gypsum developed northeast of Saltville and the last mining of the mineral occurred at Locust Cove (Figure 7). All mines and wallboard plants are not now in operation. It bears mentioning that all the known salt deposits were located " in the immediate vicinity of Saltville" (Cooper, 1966, p. 24), whereas gypsum and anhydrite deposits were found from "...a few miles southwest of Plasterco northeast to Locust Cove" (Cooper, p. 27). Major modern mining of gypsum and anhydrite was accomplished at Plasterco and Locust Cove. Salt extraction was possible only at Saltville.

The Environmental Protection Agency presently is overseeing a Superfund Site Clean-Up operation around Saltville. The site description is as follows:

> The Saltville Waste Disposal Ponds site in Smyth and Washington Counties, Virginia ...is a 125 acre site... The site consists of the Former Chlorine Plant Site (FCPS), two large waste impoundments, and areas to which contamination has migrated including the North Fork of the Holston River. The Saltville facility was in operation from 1895 to 1972. Several different waste streams were generated over that period of time. The primary contaminant of concern is mercury, which was in a waste product generated from the Chlorine Plant which operated from the early 1950s to 1972. Mercury contamination at the site has been found to threaten fish and other aquatic organisms in the River and presents a risk to those who may come in direct contact with the disposed waste or eat fish caught in the River. Mercury has contaminated the two waste ponds, the FCPS area and an undetermined length of the River (EPA, 2002).

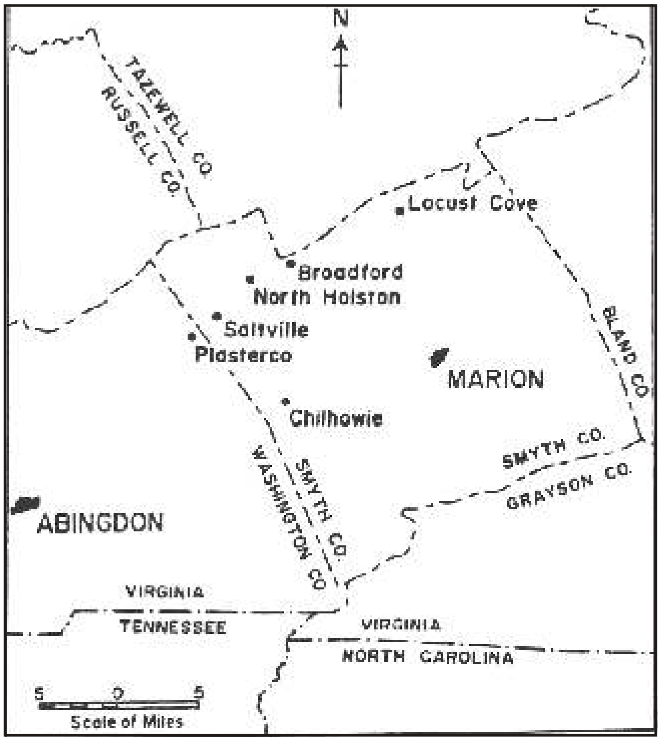

Figure 7. Location of the former evaporite mining and manufacturing facilities in Smyth and Washington Counties, Virginia (after Nelson, 1973, p. 540). Marion and Abington are county seats of Smyth and Washington Counties, respectively.

Geologic Setting

Saltville, located in northwestern Smyth County in the narrow Saltville Valley near the Washington County line, is situated within the Valley and Ridge Province of the Southern Appalachians. As stated earlier, the valley is underlain by the Maccrady Formation. Overlying the Maccrady is the Little Valley Formation, whereas the Price Formation underlies the Maccrady (Figure 8). The floor of the valley is at 1740 ft. above sea level and is approximately 8000 ft. in length and 2750 ft. at its maximum width. The valley is surrounded by peaks and knobs ranging from 300 to 600 ft. above the valley floor (Figure 9). A break in the heights occurs at the northern end of the valley at Saltville Gap (McDonald, 2000, p. 10; McDonald and Bartlett, 1983, p. 454).

The evaporites were formed in the Plasterco-Saltville-Locust Cove region of Smyth and Washington Counties (Figure 7). This area is "...in the Greendale syncline... which is truncated on the southeast, overturned side by the Saltville Fault which thrusts Cambrian onto Mississippian strata" (Warne, 1990, p. 72). This overturned southeastern limb of the syncline lying in contact with the Saltville thrust is where most of the evaporite deposits are found (Nelson, 1973, p. 539). The Greendale syncline is consid-

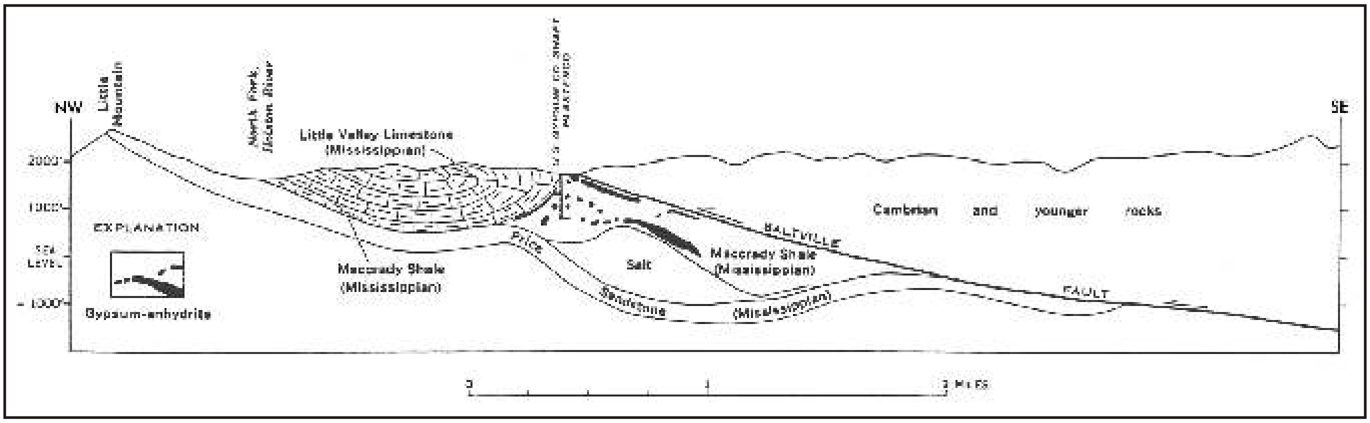
NW
Little Mountain
North Fork Holston River
Little Valley Limestone (Mississippian)
SE
2000'
1000'
SEA LEVEL
- 1000'
EXPLANATION
Gypsum-anhydrite
Maccrady Shale (Mississippian)
Salt
Maccrady Shale (Mississippian)
Price Sandstone (Mississippian)
Cambrian and younger rocks
SALTVILLE FAULT
0
1
2 MILES

Figure 8. A geologic cross section of the evaporite deposits between Plasterco and Saltville (after Withington, 1965, p. 38).

ered important because it contains the youngest formations, the Mississippian strata (according to the geologic timetable),"...occurring in the middle of the Valley between the Blue Ridge and Appalachian Plateaus" (Butts, 1973, p. 457).

The Saltville Fault has a strike length of 430 miles from northern Alabama to southwestern Virginia (House and Gray, 1982, p. 833) and stratigraphic displacement of over 16,000 feet (Sharpe, 1985, p. 43). It is considered "...the best example of large-scale footwall folds at the end of a major Appalachian thrust..." along its trace in southwestern Virginia (Milici, 1970, p. 136). It is conjectured that the folding developed prior to thrusting as Brent (1985, p. 82) noted that large synclines were completely formed in southwest Virginia before northwest moving thrusts reached the southeastern flanks of the synclines.

Various Proposals on How the Evaporites Formed

The first recorded account concerning the origin of the evaporite deposits in the Saltville region appears to have been given by W.B. Rogers (1836 reprinted in 1884). He suggested that since the pyrite-containing shale is found in fragments mixed with gypsum and clay of the salt wells, the iron pyrite (FeS_2) was oxidized producing sulfuric acid which reacted with the surrounding limestone producing calcium sulfate. Recognizing that salt deposits occur along with gypsum deposits, Stevenson (1885) advanced a similar proposal concerning the origin of the gypsum deposits. The inpouring of water from sulfur springs into a littoral lake in the deep Saltville basin reacted with dissolved calcium carbonate in solution, forming gypsum deposits.

Eckel (1903) offered a model of deposition of the interbedded salt and gypsum deposits by the mechanism of evaporation of seawater in a partially or entirely enclosed basin. Stose (1913, p. 73) concluded that the gypsum and salt minerals were:

Figure 9. Highlands above Saltville Valley looking south from the town of Saltville.

> ...derived from calcareous-argillaceous sediments which originally contained disseminated gypsum and salt precipitated in a partially inclosed [sic] arm of the sea during the deposition of the Maccrady formation, these minerals having been concentrated in the same formation by ground waters which circulated along the fault contact... dissolved the calcium carbonate from the earthy limestones, and segregated the gypsum and salt in gypsiferous and saline beds by chemical selection.

Withington (1965), observing that "...laminated gypsum, typical of bedded gypsum deposits..."(p. 39) had been found in the isolated gypsum blocks mined thus far. He assumed that the salt and calcium sulfate (likely in the form of anhydrite) were laid down as a portion of the original depositional sequence. The Maccrady near Plasterco and Saltville originally may have contained bedded calcium sulfate, salt, shale and thin sandstone in an approximately 100 feet thick unit. "The Maccrady acted as a lubricated mass over which the thrust plate glided" (p.40). During the thrusting process, the overriding matter ex-

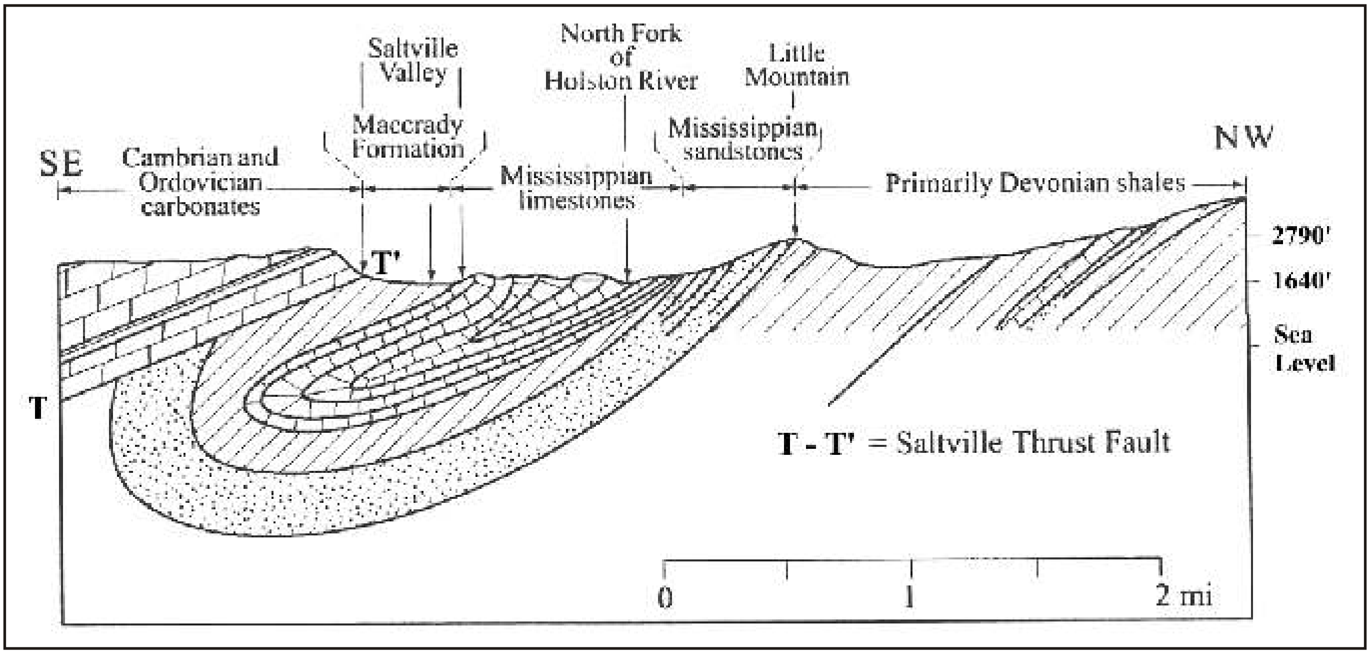

Figure 10. Geologic cross section showing the Greendale Syncline and the Saltville Thrust Fault trace in Saltville Valley region (after McDonald, 2000, p. 11).

truded the Maccrady in front of it which concentrated the $CaSO_4$ and salt by plastic flow, thickening the formation. Simultaneously, limestones and other impurities were introduced into the evaporites by the force of the thrusting process. Fragments of the Little Valley Limestone and possibly the underlying Price were moved with and into "...the jumbled mass of the Maccrady" (p. 40). Bedded gypsum found at the Plasterco mine (in the upper Maccrady) was not disturbed very much by the thrusting process as the major movement "...took place east and southeast of Plasterco" (p. 40). Figure 8 is a cross section of the evaporite deposits in relation to his model of how the beds formed in the Saltville-Plasterco area.

Byron Cooper (1966, p. 14) observed that:

> The Maccrady Formation in the Plasterco-Saltville-Broadford-Locust Cove belt of outcrop shows some of the most remarkable local stratigraphic variations of any formation in the southern Appalachians.

Cooper (pp. 11, 29) stated that the Greendale syncline was a depositional syncline where evaporites which include halite, minor blue salt, anhydrite, gypsum and dolomite occur mainly in the Maccrady plastic shale member. All of these materials originally formed as broad lenses or beds but were subjected to shearing, folding and cataclasis causing considerable disruptive flow and redistribution in the upper limb of the syncline. Salt in this limb is mainly found as tectonic breccia (cataclasts). The presence of salt breccias in the limb does not imply that all of the Saltville salt is tectonic. In the upright lower limb of the syncline, well cuttings from the high pressure brine fields have shown that some of the salt "...could be from indigenous salt beds" (p. 27).

As for gypsum and anhydrite in the mine at Plasterco, the minerals are present together as "...large lenslike to pod-shaped..." bodies in such a relationship "that the anhydrite was definitely earlier than the gypsum." The gypsum from the mines at North Holston was in bedded deposits and was completely hydrated "...but mixed with anhydrite down dip" (p. 28). The gypsum at Locust Cove is also bedded but completely hydrated (Cooper, 1966, p. 28). Later, Nelson (1973, p. 545) noted the presence of small amounts of anhydrite in some of the deepest gypsum layers at Locust Cove.

Cooper claimed that the environmental conditions necessary for a dolomite-anhydrite-halite depositional sequence are "...evaporation of marine waters in a stilled basin replenished from time to time by seawater" (p. 29). This evaporation probably occurred over at least 2000 square miles to have enough seawater to form the anhydrite found in the region.

> The special depositional conditions that must have existed in the Saltville district are noteworthy. Whereas the Maccrady on the northwest flank of the Greendale syncline is generally only about 165 feet thick at most... the thicknesses of plastic shale and evaporites in the upper Maccrady of the southeast limb, range up to 1,700 feet, signifies profound differential subsidence in the axial portion of the Greendale syncline and its northeastward extension, the Locust Cove syncline (p. 29).

A geologic section (Figure 10) of Saltville Valley illustrates the above observation. Cooper considered that this differential downwarping during the local Maccrady deposition

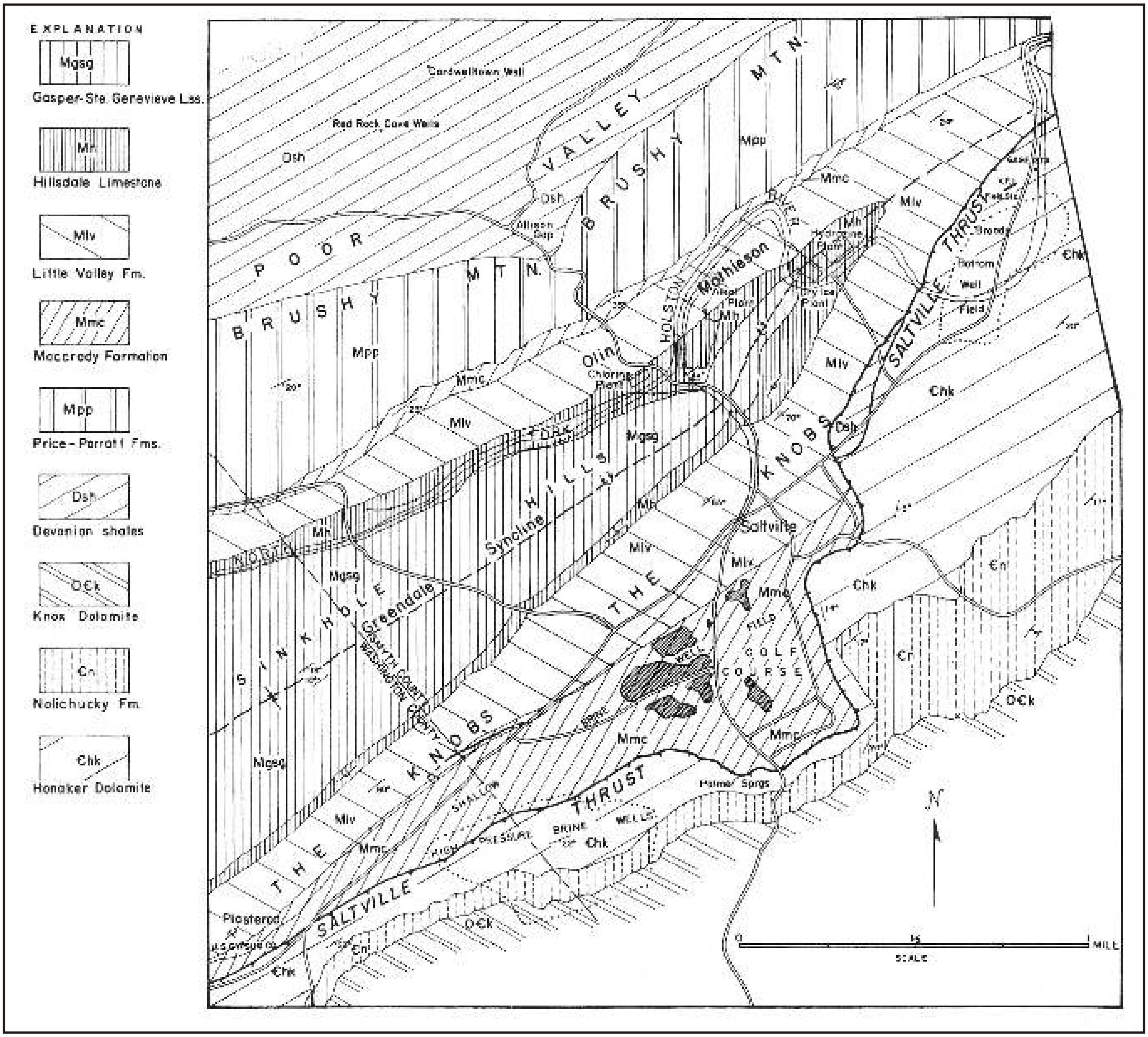

Figure 11. Geologic map of the Saltville-Palsterco region (from Cooper, 1966, p. 13).

was an “embryotectonic forerunner” of the syncline. Thus the synclinal folds were developing during the Maccrady depositional process. “Numerous repetitions of anhydrite and dolomite in the red, green and gray shales suggest cyclical conditions of evaporite formation... Overturning of the southeast limb of the fold..." (p. 30) caused anhydrite bodies to elongate into pods. The deposited anhydrite was “...hydrated wholly or partially to gypsum” (p. 30). Cooper’s interpretation of the geology of the Saltville-Plasterco area is shown in Figure 11.

> The fact that ...gypsum bodies and salt bodies are not known to occur together in the Virginia deposits may imply that the hydration of the anhydrite and dissolution of salt went on simultaneously (p. 28).

Cooper (p. 15) conjectured that Locust Cove and the Saltville-Plasterco locations probably were part of the main evaporating basin and possibly the Locust Cove deposit could have formed in a separate basin “...in which no salt and only anhydrite and possibly some dolomite were deposited by the evaporating waters” (p. 15).

Sharpe (1985, p. 44) stated that “The Maccrady Formation was deposited in a mud-rich sabkha environment.”

> Gypsum and anhydrite were deposited as diagenetic minerals within the tidal flat sediments... Ground water moves by capillary action through the sediments above the water table. Recharge occurs by lateral movement of seawater through the tidal flat wedge and periodic storm flooding (Sharpe, p. 45).

Gypsum and anhydrite were subjected to alteration and deformation after deposition forming the "boulder zone." Lenslike masses of anhydride and gypsum "...were deformed, folded and thickened by plastic flow..." when the Greendale and Locust Cove synclines were formed and the Saltville thrust was active (Sharpe, p. 46).

> A thick bed of gypsum known as the "footwall seam" occurs at the top of the Maccrady Formation in the No. 6 mine (Sharpe, p. 46).

The seam was up to 50 feet thick and was mined to a depth of 1420 feet where it graded into anhydrite. Sharpe (p. 46) considered that the seam was a shallow subtidal deposit. The seam was not present at the Locust Cove Mine.

Warne (1990, p. iii) conjectured that the thick salt and gypsum deposits in the Saltville region were the result of local syndepositional subsidence, a change from humid to arid climate as the North American Plate drifted northward and an eustatic sea-level rise. These evaporite deposits could have been thickened and concentrated into boudins by movement of the Saltville thrust fault with thixotropic clays acting as principal lubricants (p. 90).

Vertical tectonic movement could have hindered marine water movement out of the subsiding basin which would have increased brine residence time so that the waters became saturated with halite and anhydrite. The rapidly subsiding Greendale basin acted as a deep water marine salina at first where bedded gypsum, anhydrite and halite were deposited. The basin was quickly filled and leveled by deposition with primarily halite in the deepest parts of the basin. Sabkha and mudflat deposits of evaporites then became the primary mode of precipitation. Siliciclastics flowed into the basin during minor sea-level fluctuations which resulted in interbedded shales and evaporites in the Maccrady (pp. 140–149).

Some Problems with Evaporite Deposition Models

Many geologic models for the deposition of evaporites include the assumption of arid or semi-arid climate considered necessary to evaporate seawater. Krumbein (1951) cataloged the various evaporite deposits in the United States according to their position in the geologic column. Using the geologic timetable, he noted "...that evaporites occur in rocks of every system from Ordovician through Tertiary" (p. 63). Later in the article he stated that:

> ...there seems no need for calling upon "general aridity" during a geologic period to account for its evaporites. Rather, the implication for historical geology is that tectono-environmental conditions for evaporites were of common occurrence, and that the evaporites fit into the climatic picture of any period as normally expected phenomena (p. 80).

Thus, arid or semi-arid conditions may not be necessary to form evaporites. The modern geologic models that require aridity to cause evaporation include sabkhas, marginal salt pans, relict seas, desert lakes, mud flats, salt flats, barred basins and lagoons to name a few. Today, sabkhas are more frequently suggested as a mechanism for certain evaporite deposits that formed in the past. Kendall (1979a, p. 145) observed:

> The dogma of the decade—supratidal (sabkha) evaporites—has become much too one-sided because there are other evaporite types that clearly are of subaqueous origin. It is probably true that, given the correct environmental conditions, evaporites can mimic most other sediment types.

A sampling of evaporite formation models can be found in the Appendix. There is no doubt that minor evaporite deposits can presently form in small amounts by the mechanisms noted previously. It appears unlikely that the massive evaporite deposits in the geologic record are the result of such mechanisms. For instance, consider the remarks of Austin and Humphreys (1990, p. 22) on halite deposition:

> Many have assumed that the major pathway for Na^+ removal from today's ocean is the deposition of the mineral halite. However, the major halite deposits accumulate currently from concentrated river water on the continents, not from the ocean. Modern marine sedimentary deposits are nearly devoid of halite. Recent marine salt flats and coastal lagoons occur along the Persian Gulf, along the Gulf of California, and on the west coast of Australia, but they have very meager deposits of halite. When halite is deposited in marine salt flats and coastal lagoons, freshening of the brine after deposition often redissolves the halite.

The above observations support what Smith, Friedman and McLaughlin (1987, p. 826) claimed concerning salt deposition in a modern desiccating saline lake:

> The initial purpose of our study was to understand better how "primary" crystallization processes in a desiccating saline lake carry an imprint in the species and isotopic content of the hydrated minerals that can be translated into a paleoclimatic record... It is perhaps ironic that what we have determined is that in salt bodies having this bulk composition, and crystallized in an area with marked seasons, there is no such record, because the "primary" hydrated-mineral assemblages never survive more than a few months. In determining this, however, we developed a basis for predicting that the record that will survive is the mineral assemblage existing after post-depositional diagenesis has ceased. This will happen only after a saline layer is buried to depths where seasonal changes cease and near-mean annual temperatures for the area prevail, and this is probably a more useful

> component of paleoclimatic data than the one we set out to determine.

Preservation of "evaporites" may have depended upon rapid burial at depth to avoid resolution. Another controlling factor may have been the formation of evaporites in great depths of water under conditions not operating presently. Kendall (1979a, p. 145) noted that "...Areas of present day evaporite deposition comparable in size with those of the past are absent." Continuing in this direction, Whitcomb and Morris (1963, p. 412) stated that present rates of evaporation are too slow to develop huge salt deposits which later tectonic activity formed into domes. Often domes have diameters of 1000 feet to two miles and extend downward several thousand feet. Evaporation of standing water would require a column of seawater 8000 feet deep to produce a 100 feet-deep deposit of salt (p. 413).

Nevins (1974, p. 243), in discussing the Castile evaporite beds of west Texas and southeast New Mexico, explained that the ratio of $CaSO_4$ and NaCl in these beds is not in agreement with the ratio of the two compounds that would be expected from the evaporation of normal seawater. Nelson (1973, pp. 546, 547), in describing the salt deposits of Saltville noted:

> The composition of brines obtained by dissolution of the salt deposits at Saltville is notably deficient in magnesium..., and neither magnesium nor potassium bearing salts have been found. The proportions of carbonate, sulfate, and chloride in the section do not conform with those expected by progressive evaporation of seawater... In common with many salt deposits, the proportion of sulfates is too high compared to chloride. Instead, the basin must have been a relatively small one connected to the open sea in such a manner that the residual brines could be freshened after halite and anhydrite began precipitating.

Are evaporites properly labeled? Whitcomb and Morris (1963) stated "Modern writers are gradually coming to the opinion that even the stratified evaporite beds are very largely the result of metamorphic processes rather than simple sedimentation and evaporation" (p. 416). Kendall (1979a) commented:

> Lastly but most importantly, evaporites are most susceptible to extensive post-depositional change. The solubility of evaporite minerals, the tendency for metastable hydrates to be precipitated, and the susceptibility of salts to flowage under burial conditions are features unique to evaporites and have the common result of obliterating original sedimentary characteristics during diagenesis. The profound effects of these changes means that some evaporites are better considered metamorphic rocks than sediments (p. 145).

Creationist Models of Evaporite Formation

Whitcomb and Morris (1963) speculated it was possible that an evaporite bed merely had been transported by Floodwater "...from some previous location where it may have existed since the Creation" (p. 412). They suggested that a tectonic mechanism, rather than evaporation, may be more feasible to explain evaporite deposits (p. 414). Another suggestion they offered was the possibility of subaqueous volcanic activity during the Flood that would develop localized high temperature conditions which could cause the production of evaporite compounds (p. 417). Froede (2000) reinforced the concept of large-scale submarine volcanism occurring in the Flood event. Thus localized elevated temperatures necessary for hydrothermal formation of evaporites could have existed throughout the Deluge.

Nevins (1974, p. 243) noted that evaporites have been found at depths of 10,000 feet below sea level at three locations; in the Atlantic Ocean, on the margin of the continent of southwest Africa and in the Mediterranean Sea. Such deposits could not be the result of evaporation and he quoted Sozansky (1973) who suggested "...the emergence of hot brines from great depths during tectonic movements..." could have caused the precipitation of evaporites. Nevins then discussed the brine mixing experiments of O. B. Raup (1970, pp. 2246–2259) with the rapid precipitation of salt. The mixing of certain concentrations of brine solutions caused salt to precipitate in minutes. Gypsum can be precipitated rapidly by a similar mechanism (Raup, 1982, pp. 363–367). Nevins proposed a volcanic origin of brines during the Flood when the fountains of the great deep were released by tectonic forces (p. 243). In a Creation Research Society study on brine mixing, Wilcox and Davidson (1976, pp. 87–89) obtained results that indicated less rigorous conditions than those used by Raup still might achieve the precipitation of sodium chloride. Steve Austin (1984, pp. 120–121, 130–133, 223–224) abstracted several studies on evaporites as well as salt diapirism that pertain to the possibility of different mechanisms of deposition rather than evaporation. David Nutting, under the guidance of Austin, detailed a hydrothermal model for the formation of bedded salt deposits. For a brief synopsis of this treatise, see Williams (1989). The model requires the following circumstances (Nutting, 1984, p. 52) in order to be viable:

- A period of intense undersea volcanic or igneous intrusive activity.
- Widespread hydrothermal vent systems through which much water circulates.
- A basin for deposition of no specific water depth although large deposits require large basins.

Salts available for deposition are formed by a combination of two mechanisms (pp. 52–53):

- Enrichment of the salts in seawater by the circulation of normal seawater through the hydrothermal vent system.
- Direct addition of salts by magma effluence containing large proportions of salt mineral ions.

Salts can be deposited by the following mechanisms (pp. 53–54):

- Precipitation as the saline waters ascend and are cooled by the colder seawater above.
- Precipitation of salts that are less soluble in hot saline water, such as calcium carbonate and calcium sulfate, due to the heating from hotter waters coming up from below or from variations in magmatic activity.
- Precipitation resulting from the pressure release as the brine mass rises.
- Precipitation resulting from a change in the Eh of the system.
- Precipitation resulting from a change in the pH of the system.
- Precipitation resulting from a process of brine mixing where two brines of different salinities react as described by Raup (1970) and Wilcox and Davidson (1976). Also note Raup (1982).

The hydrothermal model of "evaporite" deposition is summarized and can be visualized in Figure 12.

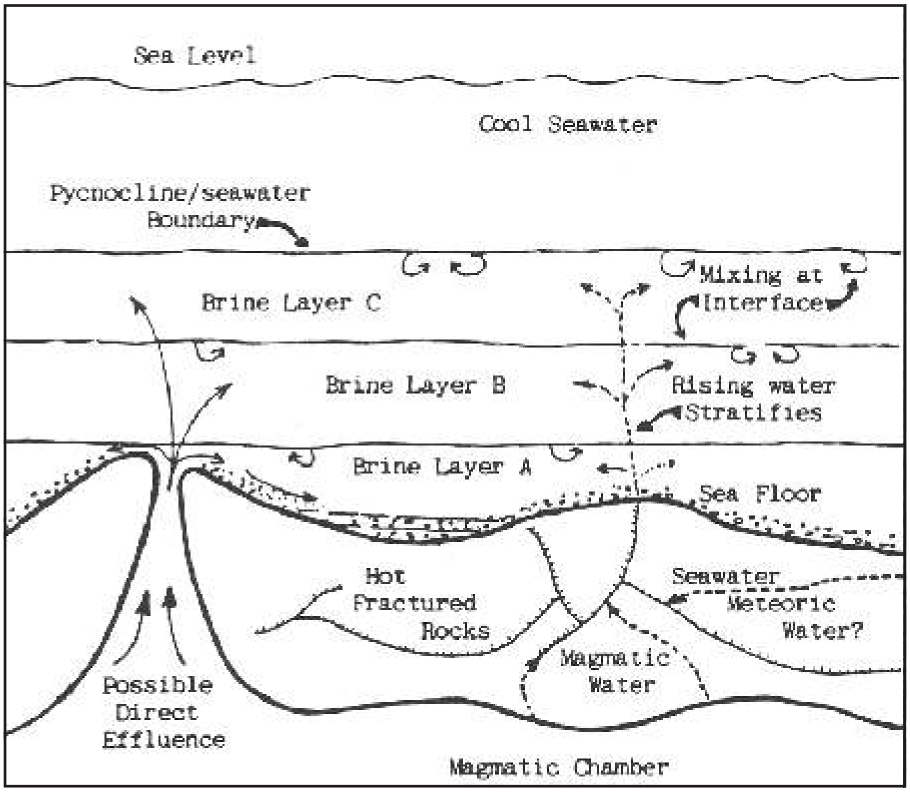

Figure 12. Hydrothermal Model of Salt Deposition (Nutting, 1984, p. 55).

Young Earth-Flood Approach to Evaporites Near Saltville, Virginia

One possible model is simply that the minerals were present in the pre-Flood crust of the earth and were dissolved by the Floodwater and transported to the Saltville region. The deposition of the evaporite compounds occurred in the subsiding Greendale basin as brines of various concentrations mixed together resulting in the precipitation of NaCl, $CaSO_4 \cdot 2H_20$ and $CaSO_4$. Another possibility is based on the Austin-Nutting hydrothermal model. Involved in this model is increased volcanic and magmatic activity during the Flood. Also hydrothermal vents could have developed (possibly the breaking up of the fountains of the great deep—Genesis 7:11) and the likely exposure of Floodwater to hot fractured rocks. Both conditions would assure the release of hot brine solutions.

If such a situation developed near the Saltville region, the warmer brine solutions would mix with cooler Floodwater (see Figure 12) precipitating NaCl, $CaSO_4 \cdot 2H_20$ and $CaSO_4$ in the subsiding Greendale basin. Anhydrite would likely precipitate from the hotter brine solutions. Seyfried (1987, p. 320) claimed that at temperatures above 150°C, anhydrite precipitation is an important sink for calcium in seawater. Halite and gypsum would possibly precipitate from mixing cooler brine solutions.

Another interesting circumstance related to this discussion is that clays, particularly chlorites, tend to form in and around hydrothermal vents which would intermix with the rising brine solutions resulting in these clays being found in the evaporite deposits. Chamley (1989, p. 14) stated that chlorites "...chiefly originate from crystalline igneous or metamorphic rocks, or from the alteration of some volcanic rocks." Nelson (1973) performed a mineralogical study of the Maccrady in the Saltville region and found that: "The evaporitic minerals are mixed intimately with clay minerals" (p. 539). Specifically he observed that:

> The evaporitic or plastic clay member at Plasterco and Locust Cove usually contains dolomite, quartz, gypsum or anhydrite, illite or muscovite and chlorite. The evaporitic member at Saltville has the composition: halite, dolomite, anhydrite, quartz, muscovite and chlorite (p. 545).

Muscovite is a mineral of the mica group and chlorite is usually found associated with and resembles the micas (Bates and Jackson 1984, pp. 86, 341). Nelson felt that the growth of chlorite was primary evidence of authigenesis and that magnesium assimilation occurred with chlorite development (1973, p. 549). In discussing hydrothermal alteration at mid-ocean ridges and seawater alteration of basalt, Seyfried (1987, p. 319) stated that chlorites and smectites form during experiments on the seawater alteration of basalt at 150–350°C (magnesium is removed from seawater during the reaction). Also SiO_2 is involved in the production of these clay particles and any unreacted SiO_2 (quartz) would likely mix with the clays.

Nelson differentiated between two varieties of chlorites present in the evaporites—a detrital variety (that possibly could have come from argillaceous sediments around the evaporitic material during tectonic movement?) and an authigenic finely crystalline variety (formed with the evaporites?). The detrital variety broke down into a friable or fragmented soil when exposed to weathering (exposure to water) as is typical of most Appalachian clays (p. 554). The authigenic "...red and green clays from the evaporitic facies flake and flocculate when in contact with water,... weathering produces a wet, cohesive and plastic clay mass..." (p. 554). Thus during weathering, the authigenic chlorites transform into an expanding clay, smectite (p.554). Chamley (1989, p. 422) noted:

> The minerals most frequently encountered in hydrothermal vents and wall-rocks are magnesian species such as chlorite, talc, serpentine, fibrous clays, corrensite, Mg-smectite and numerous non-clay minerals.

Reporting on another investigation (p. 379) Chamley observed, "In the Douala basin, Cameroon, chlorite is supposed to result from the downward transformation of smectite in a magnesian environment." He also noted that, "With increasing depth both smectite-bentonites and kaolinite-bentonites tend to be replaced by typical late-diagenetic clays such as illite-smectite, illite and even chlorite" (p. 413). Possibly the original clay formed in a hydrothermal or magmatic environment was a smectite which was transformed into a chlorite (by the magnesian environment and deep burial). Then the chlorite later weathered back into smectite? Or possibly the plastic clays are swelling chlorites or pseudo-chlorites which expand like smectites in water but resist heating like chlorites. "They appear to represent an alternation of smectite layers and octahedral brucitic sheets" (Chamley, 1989, p. 15).

In any case, the presence of chlorite and its diagenetic product, smectite, speaks of a hydrothermal or magmatic origin for the clays intimately mixed with the evaporites, supporting the hydrothermal model of Austin and Nutting. As a matter of fact, Hayden made the following remark in 1843 about the Saltville deposits:

> The local occurrence of a fault, the generally disturbed condition of the rocks, and the anhydrous nature of the salt, all argue the action of heat contemporaneously with, or subsequently to the deposition of the salt (pp. 175, 176).

Thus, I prefer the hydrothermal model for the origin of the evaporite deposits in the Saltville region.

After deposition, the tectonic action on the evaporites should be considered. The lack of strength of the evaporite beds containing clays and shales would act as a zone of weakness rendering the mass susceptible to movement if subjected to tectonic forces. Adjacent recently subaqueously-deposited limestones, dolostones, sandstones, etc. likely would be semi-rigid and more competent. As Floodwater began to recede, the crust of the earth would be subjected to folding, faulting and uplift as the height of the water above the crust was reduced. A new crustal equilibrium would be established with decreasing water pressure during the period of water recession from the continent. Faulting and crustal adjustment likely would cause movement of the evaporitic layers, squeezing them upward and outward in the Saltville region. Possibly the evaporites would be thinned and pinched out northeastward beyond Locust Cove and southwestward beyond Plasterco. The movement of the Saltville Fault might cause fragmentation of strata adjacent to the shifting evaporite beds. Many of the fragments would be carried along with the Maccrady and if some of the detritus was argillaceous, more clay (detrital variety?) would be forced into the evaporitic mass.

Cataclasis would develop as the moving salts likely would intermix forming "boulders," "pods," or "boudins" particularly in upper layers of the evaporitic mass. The deeper deposits of evaporites may have remained relatively unaffected by the tectonic forces. If after uplift the deposits were exposed to receding Floodwater currents, considerable erosion and solution of the minerals could take place, scouring the Maccrady farther downward until all that remained near the present location of Saltville was a salty, swampy area or a saline lake in the valley as the sediments in the heights around the valley dried and hardened. Eventually the sedimentary layers around and below the Maccrady would harden, stabilizing the strata as tectonic movement lessened and then ceased.

The models offered are considered tentative and more study is necessary to reinforce or reject these ideas. There are likely other evaporite deposits that would lead an investigator to entirely different conclusions. The tectonism that occurred would destroy or disturb most of the original bedding of the evaporites, making any investigation a difficult undertaking.

Glossary

argillaceous: containing clay
authigenic: formed in place
boudin: sausage-shaped segment
brucite: hexagonal mineral, $Mg(OH)_2$
cataclasis: rock deformation by fracture, crushing or granulation

chlorite: a group of platy usually greenish clay minerals. Chlorites are associated with and resemble micas.
corrensite: clay mineral with a structure that represents the interstratification of chlorite and vermiculite structures or of chlorite and smectite structures
diapirism: piercing or rupturing of domed or uplifted rocks by mobile core material
eustatic: pertaining to worldwide changes of sea-level
evaporites: sedimentary salts precipitated from aqueous solution and concentrated by evaporation
illite: general name for a group of three-layer, mica-like clay minerals
littoral: pertaining to the benthic environment or depth zone between high and low water
magmatic: pertaining to or derived from magma
muscovite: a mineral of the mica group
pycnocline: a density gradient; a layer of water in the ocean characterized by a rapid change of density with depth
sabkha: a supratidal environment of sedimentation formed under arid to semiarid conditions on restricted coastal plains just above normal high tide
salina: a body of saline water such as a salt pond, spring or playa lake
salt pan: a small shallow depression where water accumulates and evaporates leaving a salt deposit
serpentine: a group of rock-forming minerals with the formula $(Mg,Fe)_3Si_20_5(OH)_4$
smectite: a group of expanding-lattice clay minerals
talc: soft, green or gray mineral, $Mg_3Si_4O_{10}(OH)_2$
thixotrophic: change from a gel to a sol when disturbed, a property of colloids such as bentonitic clay

Acknowledgments

The gracious help of the personnel of the Saltville Public Library is definitely appreciated. All of the people with whom I talked in Smyth County about various subjects concerning the evaporite deposits, mining and manufacturing locations, etc. were most kind and helpful. Carl Froede, Jr. prepared the graphics for the figures and provided some useful information. Jerry Akridge also aided in the literature search. I am indebted to Carl, Jerry and John Reed for their encouragement and suggestions to improve the manuscript. I thank the many donors to the Creation Research Society Research Fund, interest from which financed a portion of these studies.

Appendix

Interested readers may consult the following references for various uniformitarian models of evaporite deposition: Dean, Davies and Anderson, 1975, pp. 367–372; Evans, 1970, pp. 1349–1352; Friedman, 1972, pp. 1072–1086; Hardie, 1984, pp. 193–240; Kendall, 1979a, pp. 145–157; 1979b, pp. 159–174; Kinsman, 1969, pp. 830–840; 1974, pp. 343–348; Presley, 1987, pp. 167–190; Warren and Kendall, 1985, pp. 1013–1023.

References

CRSQ: Creation Research Society Quarterly

Austin, S. A. 1984. *Catastrophes in earth history*. ICR Technical Monograph 13. Institute for Creation Research, El Cajon, CA.

Austin, S. A. and D. R. Humphreys. 1990. The sea's missing salt: a dilemma for evolutionists in Walsh, R. E. and C. L. Brooks (editors). *Proceedings of the second international conference on creationism July 30–August 4*. Volume II—Technical symposium sessions and additional topics, pp. 17–33. Creation Science Fellowship, Pittsburgh.

Bates, R. L. and J. A. Jackson. 1984. *Dictionary of geological terms* (third edition) Anchor Books, New York.

Brent, W. B. 1985. Relative age of large folds and major thrusts in the Valley and Ridge of northeastern Tennessee and adjacent Virginia. *Geological Society of America Southeastern Section Abstracts with Programs* 17(2):82.

Butts, C. 1973. Geology of the Appalachian Valley in Virginia, Part 1: Geologic text and illustrations. *Virginia Geological Survey Bulletin 52 reprint*. Charlottesville.

Chamley, H. 1989. *Clay sedimentology*. Springer-Verlag, New York.

Cooper, B. N. 1966. Geology of the salt and gypsum deposits in the Saltville area, Smyth and Washington Counties, Virginia in Rau, J. L. (editor). *Second symposium on salt, Volume 1: Geology, geochemistry and mining*, pp. 11–34. Northern Ohio Geological Society, Cleveland.

Craig, J. R. 1973. *Geologic evaluation of the Saltville area, Smyth County Virginia*. Saltville Planning Commission.

Dean, W. E., G. R. Davies and R. Y. Anderson. 1975. Sedimentological significance of nodular and laminated anhydrite. *Geology* 3:367–372.

Eckel, E. C. 1903. *United States Geological Survey Bulletin 213* as quoted in Stose, G. W. 1913.

EPA. 2002. *Saltville waste disposal ponds, current site information*. http://www.epa.gov/reg3hwmd/super/VA/saltville-waste/pad.htm.

Evans, R. 1970. Sedimentation of the Mississippian evaporites of the Maritimes: An alternate model. *Canadian Journal of Earth Sciences* 7:1349–1352.

Friedman, G. M. 1972. Significance of Red Sea in problem of evaporites and basinal limestone. *American Association of Petroleum Geologists Bulletin* 56:1072–1086.

Froede, Jr., C. R. 2000. Submarine volcanism: Part I—Subaqueous basalt eruptions and lava flows *CRSQ* 37: 22–35.

Hardie, L. A. 1984. Evaporites: Marine or non-marine? *American Journal of Science* 284:193–240.

Hayden, C. B. 1843. On the rock salt and salines of Holston. *American Journal of Science and Arts* 44:173–179.

House, W. M. and D. R. Gray. 1982. Displacement transfer at thrust terminations in Southern Appalachians-Saltville thrust as example. *American Association of Petroleum Geologists Bulletin* 66:830–842.

Kendall, A. C. 1979a. Continental and supratidal (sabkha) evaporites in Walker, R. G. (editor). *Facies models*, pp. 145–157. Geoscience reprint series 1. Toronto.

Kendall, A. C. 1979b. Subaqueous evaporites in Walker, R. G. (editor). *Facies models*, pp. 159–174. Geoscience reprint series 1. Toronto.

Kinsman, D. J. J. 1969. Modes of formation, sedimentary associations, and diagnostic features of shallow water and supratidal evaporites. *American Association of Petroleum Geologists Bulletin* 53:830–840.

Kinsman, D. J. J. 1974. Calcium sulphate minerals of evaporite deposits: Their primary mineralogy in Coogan, A. H. (editor). *Fourth symposium on salt, Volume 1*, pp. 343–348. Northern Ohio Geological Society. Cleveland.

Krumbein, W. C. 1951. Occurrence and lithologic association of evaporites in the United States. *Journal of Sedimentary Petrology* 21:63–81.

McDonald, J. N. 2000. An outline of the Pre-Clovis archaeology of SV-2, Saltville, Virginia, with special attention to a bone tool dated 14,510 yr BP. *Jeffersoniana Number 9*. Virginia Museum of Natural History, Martinsville.

McDonald, J. N. and C. S. Bartlett, Jr. 1983. An associated musk ox skeleton from Saltville, Virginia. *Journal of Vertebrate Paleontology* 2:453–470.

Milici, R. C. 1970. The Allegeny structural front in Tennessee and its regional tectonic implications. *American Journal of Science* 268:127–141.

Nelson, B. W. 1973. Mineralogy of the Maccrady Formation near Saltville, Virginia. *American Journal of Science* 273-A:539–565.

Nevins, S. E. 1974. Reply to critique by Daniel Wonderly. *CRSQ* 10:241–244.

Nutting, D. I. 1984. *Origin of bedded salt deposits: A critique of evaporative models and defense of a hydrothermal model*. unpublished Master's thesis. Institute for Creation Research, El Cajon, CA.

Ogle, D. W. 1999. *Unusual habitats and rare species of southwestern Virginia*. Historical Society of Washington County, Virginia, Abington.

Presley, M. W. 1987. Evolution of Permian evaporite basin in Texas Panhandle. *American Association of Petroleum Geologists Bulletin* 71:167–190.

Raup, O. B. 1970. Brine mixing: an additional mechanism for formation of basin evaporites. *American Association of Petroleum Geologists Bulletin* 54:2246–2259.

Raup, O. B. 1982. Gypsum precipitation by mixing seawater brines. *American Association of Petroleum Geologists Bulletin* 66:363–367.

Rogers, W. B. 1884. *A reprint of annual reports and other papers on geology of the Virginias*. D. Appleton. New York.

Seyfried, Jr., W. E. 1987. Experimental and theoretical constraints on hydrothermal processes at mid-ocean ridges. *Annual Review of Earth and Planetary Sciences* 15:317–335.

Sharpe, R. D. 1985. Geology and mining of gypsum in Virginia in Glaser, J. D. and J. Edwards (editors). *Proceedings, twentieth forum on the geology of industrial minerals, May 15–18, 1984*: *Industrial minerals of the Mid-Atlantic states*, pp. 41–49. Maryland Geological Survey Special Publication No. 2. Baltimore.

Smith, G. I., I. Friedman and R. J. McLaughlin. 1987. Studies of Quaternary saline lakes—III: Mineral, chemical and isotopic evidence of salt solution and crystallization processes in Owens Lake, California, 1969–1971. *Geochimica et Cosmochimica Acta* 51: 811–827.

Sozansky, V. I. 1973. Origin of salt deposits in deep water basins of Atlantic Ocean. *American Association of Petroleum Geologists Bulletin* 57:589–590.

Stevenson, J. J. 1885. *Proceedings of the American Philosophical Society* 22:157–160 as quoted in Stose, G. W. 1913.

Stose, G. W. 1913. Geology of the salt and gypsum deposits of southwestern Virginia, pp. 51–73. *Virginia Geological Survey Bulletin 8*. Charlottesville.

Warne, A. G. 1990. *Regional stratigraphic analysis of the Lower Mississippian Maccrady Formation of the central Appalachians*. Unpublished Ph.D. thesis. The University of North Carolina at Chapel Hill.

Warren, J. K. and C. G. St. C. Kendall 1985. Comparison of sequences formed in marine sabkha (subaerial) and salina (subaqueous) settings—modern and ancient. *American Association of Petroleum Geologists Bulletin* 69:1013–1023.

Watson, T. L. 1909. Annual report on the mineral production of Virginia during the calendar year 1908, pp. 119–120. *Virginia Geological Survey Bulletin No. 1-A*. Charlottesville.

Whisonant, R. C. 1996. Geology and the Civil War in southwestern Virginia: The Smyth County Salt Works. *Virginia Minerals* 42(3):21–30.

Whitcomb, Jr., J. C. and H. M. Morris. 1963. *The Genesis Flood*. Presbyterian and Reformed Publishing. Philadelphia.

Wilcox, F. L. and S. T. Davidson. 1976. Experiments on precipitation brought about by mixing brines. *CRSQ* 13:87–89.

Williams, E. L. 1989. Origin of bedded salt deposits (Nutting). *CRSQ* 26:15–16.

Withington, C. F. 1965. Suggestions for prospecting for evaporite deposits in southwestern Virginia. *Virginia Minerals* 11:37–41.

Book Review

The Colorado Plateau, A Geologic History by Donald L. Baars
University of New Mexico Press, Albuquerque. 2000, 254 pages, $21.95

From a geological standpoint there are few areas in North America that are more fascinating than the Colorado Plateau. Roughly centered on the "Four Corners Area" where Arizona, Colorado, New Mexico, and Utah meet, this immense area provides vast stretches of deep canyons, burning deserts, and sculpted spires. The scant vegetation and abrupt escarpments of the area allows a visualization of the topography that would be concealed by dense vegetation elsewhere.

A large number of books attempt a thorough but nontechnical review of the geology of the Colorado Plateau, but few really succeed. This book is a delightful exception. While the author is a convinced evolutionist and uniformitarian, he nevertheless presents some refreshing insights into the dogmatism of classical historical geology. As a field geologist with more than forty years experience on the Colorado Plateau, his skepticism of several modern geological interpretations must be taken seriously.

Baars wastes no time in announcing some of his heretical thoughts in the Introduction. He states, for example, "We have learned many things about the fundamental structure of the earth thanks to the religious doctrine of plate tectonics, a widely and now almost blindly accepted theory that is based on continents skidding promiscuously across the crust of the earth. Although this doctrine is based on surmised oceanographic processes, all geologic features of the continents must adhere to prescribed policy, even though many of these interpretations make no sense . . . If the real geologic facts don't agree with plate tectonics principles, they are simply ignored."

The author also asks, "What constitutes windblown (eolian) sandstone?. . . Where did all the sand come from, anyway?" He notes that extensive literature exists on the internal structure of supposedly wind-blown sand dunes, but "One cannot find a single reliable technical paper on what is to be found inside water-deposited dune sands . . . So we end up knowing everything there is to possibly know about windblown sand deposits, and virtually nothing about water-laid sand accumulations."

This issue is of immense importance to flood catastrophists who tend to view many classical sandstone strata as flood deposits. If many or most of the supposed windblown, cross-bedded sandstone strata are in reality water deposited, it would cast many geological processes of erosion, transportation, and deposition in an entirely new light.

Baars also expresses concern about the geological time tables as applied to stratigraphy. He writes, "Another problem of worldwide significance that affects our discussion of the geological history of he Colorado Plateau, or any other province, is that of the time boundaries of he geologic periods." His special concern is with the boundaries of the Permian Period, which he observes have "vacillated wildly since the Permian Period was established by Sir Roderick Murchison in 1841 . . ."

Young earth creationists will find much of Baars work to be a refreshing departure from the standard evolutionary dogmatism. Furthermore, it is clear from this work, as well as from many others, that the Colorado Plateau contains a vast goldmine of information awaiting careful analysis within the appropriate interpretive framework.

This work is highly recommended to any traveler of the back country of the Colorado Plateau. Though written at a semi-popular level, it is very readable for the non-specialist. In addition, its extensive bibliography and index makes it an ideal starting point for in-depth studies of this high, wide and lonely area.

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The Pre-Fall Mortality of Aquatic Autotrophs and Other Designated *Nephesh* Kinds

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Abstract

Of three positions regarding the pre-Fall consumption of lower aquatic creatures, one is seldom taken (and rightfully so): that these creatures are actually plants. A second position is that these small creatures indeed experienced pre-Fall death, but that lacking *nephesh* life, this death was and is as benign as vegetative death. Thus, there is an implied creative category between "vegetation" and "creature." A third view is posited here: that these primary and secondary creatures indeed possess *nephesh* life, yet their original provisionary nature for other creatures' consumption is physiologically evident and biblically allowable. This third view of pre-Fall mortality can be adopted without supporting the evolutionary idea of death as a creative mechanism.

Introduction

The impetus for exploring various aspects of pre-Fall mortality is that present creation scholarship does not offer a normative, compelling position on the matter. In addition, evolutionists might find ample opportunity in this regard to discredit biblical creation presuppositions.

It is not difficult for biblical creationists to envision the pre-Fall "mortality" of vegetation. Plant material was clearly given for original consumption (Genesis 1:29–30). Though consumption need not affect an entire plant, it is nonetheless fatal to grazed herbaceous seedlings, or to seeds themselves (viable embryonic plants) eaten by birds.

In addition to stating this purpose outright, the creation account also gives rationale for this provision, attributing to vegetation none of the *nephesh* (Consult glossary at the end for definitions of this and other Hebrew words) possessed by creatures (see Figure 1). This *nephesh* principle involves being created from nothing *(bara)* rather than simply brought forth or produced (*asah, yatsa,* respectively) of material already in existence. In fact, vegetative kinds are not regarded as "living" (Stambaugh, 1989) or "living creatures" (Morris, 1993; Ham, et al., 1990) in Scripture. These are set apart from prior works of creation in that they follow reproduction according to kinds, but this is the only biblical rationale for regarding vegetation as "living" organisms in the sense used today. Having an entirely unique life nature, it is therefore reasonable to regard vegetative death as unique. In a similar vein, we speak of *apoptosis*, or pre-programmed cell "death" as yet another benign and usually purposeful end.

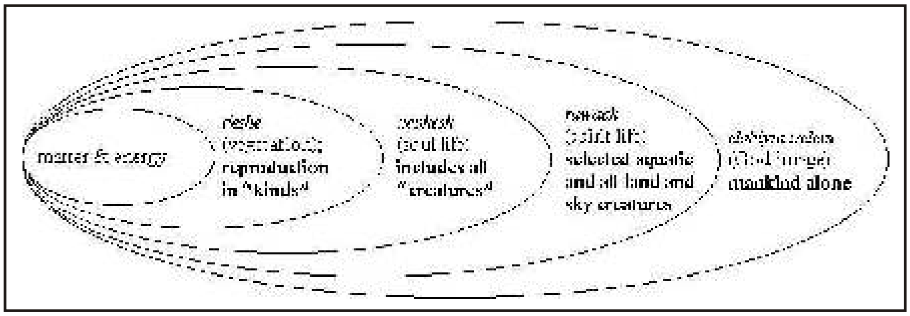

Figure 1. Nested hierarchy of life-natures in the creation. Successive acts of creation established kinds that are inclusive of the life-natures of previously created kinds. For example: An antelope breathes / which animates its life as a creature / that belongs to a unique kind / which is a special information-driven form of matter and energy. An antelope, however, does not possess God-image, and a squid possesses neither spirit nor God-image. Definitions in glossary.

Accepting the possibility of *nephesh* death before the Fall, however, is another matter, resisted by biblical creationists for good reasons including: 1) the biblical inference that such widespread death resulted from the Fall of man, and 2) the biblical fact that death was not offered as God's mechanism for bringing forth created kinds.

Difficulty in the matter of pre-Fall death arises when discrimination is unclear between vegetation and "creatures," or between the life nature of plant cells and the life nature of creatures. For example, aquatic producers in-

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clude "phytoplankton" that are no longer regarded as "plants" merely because of their photosynthetic nature, nor as "animals" simply because of their motility. The five-kingdom system now has these former "plants" distributed among two new kingdoms other than the *Plantae* and *Animalia* kingdoms. The cyanobacteria, or blue-green bacteria, for example, are placed in the *Monera*, and the dinoflagellates, euglenoids, and diatoms are found in the *Protista*. In the scheme of the days of creation, though, where do these phytoplankton forms belong, and what is their place in the pre-Fall food supply?

Possible Biblical Classification Scenarios

Three biblical scenarios have been offered for classifying the phytoplankton:

1. Perhaps these photosynthetic organisms should be regarded as day three vegetative kinds because they are photosynthetic, in which case the idea of no pre-Fall creature death is preserved. Understandably, one is hard-pressed to find this position in creationist literature, because it places too much value on the criterion of photosynthesis, and is therefore at odds with both biblical and present taxonomic categories.

2. These organisms (and perhaps others) might be regarded as "non-*nephesh*" animals, allowing for them to be day five (or day six) creatures while retaining a benign death akin to that of vegetation. Many hold this position, but it is a biblical stretch. Several creationists state this absence of *nephesh* in some creatures explicitly, as characterized perhaps by the absence of consciousness (Stambaugh, 1989), or by the lack of blood, though problems are admitted with this criterion (Ham et al., 1990). At other times the qualifying term "*nephesh* animals" (AIG, Illustrations) is used, which also suggests, though less explicitly, that there are some animals that do not possess *nephesh*. It seems that this special classification is inserted so as to not compromise with the death generalization made by the same scientists, such as "death only entered the world when sin came in through man" (Morris, 1976), or "death, both physical and spiritual, entered into this world subsequent to—and as a direct consequence of—man's sin" (AIG Statement of Faith). Despite these prevailing interpretations, here is one biblical indication that *nephesh* should instead be applied more liberally:

> And God created great whales, and *every* living creature [*nephesh*] that moveth, which the waters brought forth abundantly... (Genesis 1:21a KJV, emphasis and brackets added)

The NIV renders this passage as follows:

> So God created the great creatures of the sea and *every* living and moving thing with which the water teems...(emphasis added)

At the very least, then, any creature that is self-motile cannot be placed in a non-*nephesh* life classification between vegetation and *nephesh* creatures. Nonetheless, "moving" need not be restricted to self-powered locomotion, and is likely stated simply in contrast to the rooted nature of vegetation. To designate a small classification of creatures that are not self-motile at any stage of development (and perhaps that also lack consciousness or blood) is not warranted by the biblical record. Therefore I do not accept the existence of "non-*nephesh*" animals. Note that such a designation would produce an additional "bubble" in Figure 1 (between the second and third groupings) which would have no biblical Hebrew descriptor.

3. These organisms can be assessed as day five creatures, possessing *nephesh*, and thus some pre-Fall *nephesh* mortality is implied. I argue for this position. Doing so does not necessarily justify pre-Adamic death as a mechanism for evolution, nor need it lead to a watering-down of the primary physical consequence of the Fall of man. Mankind and all kinds were created originally complex and by God's supernatural action, not through processes involving death, as maintained in evolution theories. And mankind's death is a direct consequence of the Fall. The contention here is simply that the physiological evidence and the biblical record both suggest that certain designated *nephesh* creatures possessed a purposeful pre-Fall mortality.

Arguments for Designated Pre-Fall *Nephesh* Mortality

First, we should establish that mortality among non-vegetative kinds is indeed implied by the biblical record of creation. It can be argued biblically that aquatic autotrophic creatures are by default a provision for the aquatic food chain. To see this, we look at the provision that is explicitly stated for mankind, and creatures of land and sky:

> And God said, Behold, I have give you [mankind] every herb [*eseb*] bearing seed, which is upon the face of all the earth, and every tree [*ets*],in the which is the fruit of a tree yielding seed; to you it shall be for meat. And to every beast of the earth, and to every fowl of the air, and to every thing that creepeth upon the earth, wherein there is life, I have given every green herb [*eseb*] for meat: and it was so. (Genesis 1: 29–30 KJV, brackets added)

Originally, all vegetative kinds, herbaceous (*eseb*) and woody (*ets*), were given to mankind. Only herbaceous vegetative kinds (*eseb*), however, were given to creatures of the land and sky. Aquatic creatures are conspicuously absent from receiving either provision. What they were supposed to consume is left to reason. If plants were the only autotrophic organisms, this would indeed be puzzling; yet one can observe very small aquatic organisms that are food by design, for other aquatic creatures. Aquatic autotrophs can be inferred to fit this biblical void regarding aquatic provision.

Second, we can further examine the physiology of phytoplankton to see that they indeed would have carried out this role from the outset, and not simply as a post-Fall modification. One can realistically posit the extravagant (but bounded) expression of a genome as sufficient for the "switching" on of carnivorous mechanisms in many animals today (Tyler, 1996; Catchpoole, 2000; Wieland, 1995). Yet it is unlikely, and not observed, that photosynthetic processes emerged after the Fall in formerly non-photosynthetic creatures. Photosynthesis is irreducibly complex, and very much a part of the essential teleonomy of an organism that possesses it. Creationists acknowledge God as the designer of irreducibly complex structures. A distinction can be made, however, between developmental programs (those embryological processes that govern differentiation itself), and genetic programs (that express those fixed structures in various ways). The level of complexity of photosynthetic mechanisms is something dictated by innate developmental programs, and not an expression of minor genetic alterations. To be sure, it is possible that God might have overridden and augmented such large-scale body type characteristics after the Fall, but this type of "re-creation" is not necessitated biblically, and such a mechanism is typically not favored by creationist biblical scholarship, as indicated by the authors above as well as Morris (1976). One might also note that suggested post-Fall expressions of latent genes are thought to affect an organism's advantage in predation (e.g., attack instinct or sharp claws) or defense (e.g., disguise or foul taste). Yet an emergence of photosynthetic mechanisms would not be consistent with such advantages.

Pre-Fall mortality in phytoplankton having been established, the third matter is to discern that these are indeed *nephesh* organisms. They cannot be regarded as "vegetation" biblically, just as they are no longer regarded as "plants" taxonomically. Biblical vegetation, or *deshe* (see Figure 1 and glossary), is "sprung forth" from the land and rooted, not motile. Never are the main biblical Hebrew words for vegetation (*deshe, eseb,* and *ets,*) used in any other context. The creatures of day five, however, are regarded as "moving" (*sherets*), and this would include the phytoplankton, whether actively motile or passively motile, in contrast to the rooted nature of vegetation. As stated earlier, the biblical record of creation moves directly from vegetation to creatures, and does not indicate an in-between category. In this regard, the former two-kingdom taxonomic system more closely parallels biblical criteria (other than in its treatment of mankind), as it forces organisms to be regarded as either plant or animal based on motility rather than devising other large-scale kingdoms based on other criteria, e.g. *Monera* as unicellular and prokaryotic, *Protista* as unicellular and eukaryotic, or *Algae* as photosynthetic yet unlike "higher" plants physiologically. The suggestion of pre-Flood "floating forests," with radial roots and hollow interiors (Wieland, 1995) may call into question whether all vegetation is originally rooted in land, but this is another topic for discussion that does not bear upon the minute organisms in question here. Such floating vegetation would still be accepted unilaterally as a day three work.

Fourth, one can examine the comparatively benign type of death that these aquatic autotrophs experienced before the Fall. Even as *nephesh* organisms, their death was not the cessation of breath, or *ruwach*, a higher mode of life than *nephesh* alone (see Figure 1 and glossary). (This distinction may be in part why some persons intuitively endorse fishing while abhorring hunting and whaling.) Furthermore, their death was not disease-induced, or the result of lifespan limits. Even today, their consumptive death is not wasteful, because the whole organism is completely acquired for energy. And it is not extended in suffering, since the organism is consumed immediately. Death in such small autotrophs is not the cruel "futility of nature" (Stambaugh, 1996) that "makes God out to be a monster" (Morris, 1976), leading the uninformed theist to question God's goodness (Morris, 1993); nor does it support theistic evolution. To be consumed was their essential purpose, and it is a purpose preserved among these aquatic autotrophs today. In short, the teleological considerations outweigh the mortality "problems."

Fifth, one must acknowledge that the death introduced at the Fall of man is spoken of explicitly regarding only mankind. One can infer that the "groaning" and "decay" of creation is a result of man's death. Creatures die, not because they have sinned (Morris, 1976), but because of the condition to which the creation has been subjected. But this does not mean that all types of death were introduced at the Fall.

> For the wages of sin is death, but the gift of God is eternal life in Christ Jesus our Lord. (Romans 6:23 KJV)

Note the specific context of the above: The wages of [man's] sin is [man's] death, but the gift of God [to man] is eternal life....Paul obviously was directing both sides of this verse to human beings only. Other Scriptures reinforce the same specificity:

> Therefore, just as [man's] sin entered the world through one man, and [man's] death through sin, and in this way death came to all men, because all sinned—for before the law was given, sin was in the world. But sin is not taken into account when there is no law. Nevertheless, [man's] death reigned from the time of Adam to the time of Moses, even over those who did not sin by breaking a command, as did

> Adam, who was a pattern of the one to come. (Romans 5:12–14 KJV, brackets added)
>
> And the LORD God commanded the man, "You are free to eat from any tree in the garden; but you must not eat from the tree of the knowledge of good and evil, for when you eat of it you [mankind] will surely die." (Genesis 2:16–17 KJV, brackets added)

Finally, one might note that most of the arguments above need not be restricted to autotrophs. Given the ambiguity of the original aquatic food provision, the uncertain scope of non-human death resulting from the Fall, and the presence of similar non-*ruwach* modes of *nephesh* life in many aquatic creatures other than the autotrophs, one is left to wonder whether *other* aquatic creatures were also producers originally. If God employed one original level of consumption (of chemosynthetic and photosynthetic producers), what is to say that a second level (zooplankton, or secondary producers) was not also in place? Perhaps all self-sacrificing kinds are not necessarily autotrophic. Diatoms, cyanobacteria, and other autotrophs could just as well have joined ciliates, small crustaceans, and other zooplankton in providing nourishment for the rest of aquatic creatures. As support, consider that baleen whales obtain their plankton by straining large volumes of water, without the capacity to select only autotrophs. Though feeding selectivity *by* zooplankton may be observed, according to size, shape, and smell, these creatures can only discriminate proportionally (not completely), and do so typically *among* autotrophs (Koehl, 1984). Can one suppose realistically that much larger consumers somehow accomplished selectivity between minute autotrophs and non-autotrophs before the Fall?

Conclusion

We can thus see that the recognition of pre-Fall mortality of autotrophs and other *nephesh* organisms hinges largely on two matters: First, the acceptance that primary and secondary producers other than vegetative kinds must have had an original place in supplying the aquatic food chain, and second, that these organisms indeed possess *nephesh* life.

Editor's Note: Interested readers may wish to consult the following *CRSQ* notes and letters dealing with the subject matter in this article:

Klotz, J. W. 1980. Is the destruction of plants death in the Biblical sense? *CRSQ* 16:202–203.

Akers, Jr., H. 1993. Tree of life. *CRSQ* 30:62.

Vorpahl, P. V. 1997. Predators and paradise, one more time. *CRSQ* 34:84–85.

Peterson, E. 1998. Reply to P. V. Vorpahl's article. *CRSQ* 35:48–49.

Klevberg, P. 1998. More comments on "Predators and paradise: one more time." *CRSQ* 35:49–50.

Glossary

deshe: Used first in Genesis 1:11, translated as "grass" (KJV, NKJV), or "vegetation" (NIV, NASB, RSV). From the root *dasha*, which carries the idea of "springing forth" (Online Bible, 2001). Although several translations and commentaries (Morris, 1976) regard *deshe* as one in a list of three broad orders of plants, e.g. "let the earth put forth vegetation [*deshe*], plants [*eseb*]..., and fruit trees [*ets*]..." (RSV), the NIV regards *deshe* as inclusive of the latter two by following it with a colon. The author prefers the latter, in which *deshe* is the most generic word for vegetation (Berndt, 2000). Vegetative kinds, though clearly unique from non-living matter, are not regarded biblically as a "living souls" (*chayyay nephesh*).

nephesh: Used first in Genesis 1:20 at the creation of water and sky creatures, and correlated to the words for movement (*sherets*) and life itself (*chay*). Translated as "soul" primarily in the KJV, and "creature" primarily in the NIV. Paralleled by the New Testament's Greek word *psuche*.

ruwach: Not used until the Flood account in Genesis 6:17, yet ascribed to both mankind and many creatures (Morris, 1976). Most often translated "spirit," but also "wind" or "breath." Its less-frequent counterpart is the word *neshamah* which is used in Genesis 2:7 of man's creation and typically translated "breath [*neshamah*] of life [*chay*]." Thus, the emphasis is made of God's personal breathing of life into man, such that he became a living soul [*nephesh*] in this special way. It is this emphasis taken without comparison to Scriptures outside of the creation account, that perhaps leads to the erroneous understanding that "spirit" is what sets mankind apart from animals. *Neshamah*, as with *ruwach*, is not exclusive to mankind, as it is ascribed to other creatures in Genesis 7:22. For a further discussion of the distinction between *ruwach* and *neshamah* in biblical use, see reference (Berndt, 2002). *Ruwach* is paralled by the new Testament's Greek word *pneuma*.

elohiym tselem: This "God-image" is what ultimately sets man's life nature apart from all other organisms. (Man is also set apart in his mandate to rule over the earth and its creatures, in the personal manner of his creation, and in the fact that he is the lone kind in God's final act of creation, created with no other creatures simultaneously.) Some writers have attempted to define the characteristics and outworking of this God-image through observing mankind in the present. Consult references for further reading on the characteristics of God-image (Gitt, 1999; Morris, 1976).

References

CEN: *Creation Ex Nihilo*

Answers in Genesis. Illustrations - Romans 5:12. http://www.answersingenesis.org/home/area/overheads/pages/oh20010713_49.asp Accessed 12 March 2002.

Answers in Genesis. Statement of faith. http://www.answersingenesis.org/home/area/about/faith.asp Accessed 15 June 2002.

Berndt, Chard. 2000. *Biblical classification of life: a framework and reference for authentic biblical biology*. pp. 58–61. Elihu Publishing, Filer, ID.

———. 2002. Does *ruwach* life require active respiration? http://www.creationbydesign.com/articles/does_ruwach_require_active_respiration.pdf Posted February 2002.

Catchpoole, David. 2000. Piranha. *CEN* 22(4):20–23.

Gitt, Werner. 1999. *The wonder of man*. pp. 99–105. Christliche Literatur-Verbreitung, Bielefeld, Germany.

Ham, Ken, Andrew Snelling, and Carl Wieland. 1990. *The answers book*. pp. 103–105. Master Books, Green Forest, AR.

Koehl, M.A.R. 1984. Mechanism of particle capture by copepods at low reynolds numbers: possible modes of selective feeding. In: Meyers, Dewey G. and J. Rudi Strickler, editors. *Trophic interactions within ecosystems*. Ch. 7, pp. 135–166. Westview Press, Boulder, CO.

Morris, Henry M. 1976. *The Genesis record*. pp. 62, 69, 73–74, 78–80, 119, 125. Baker Book House, Grand Rapids, MI.

———. 1993. *Biblical creationism*. pp. 21–22, 68. Baker Books, Grand Rapids, MI.

Online Bible Hebrew lexicon. 2001. Version 1.02.01 Timnathserah Inc. Winterbourne, Ontario, Canada. http://www.onlinebible.net.

Stambaugh, James. 1989. Death before sin? *ICR Impact No. 191*.

———. 1996. Creation and the curse. *ICR Impact No. 272*.

Tyler, David J. 1996 Herbivores, carnivores, and the created order. *Creation Matters* 1(3):1–2.

Wieland, Carl. 1995. Forests that grew on water. *CEN* 18(1):22–24.

———. 1999. Well-armed water fleas and radishes. *CEN* 22(1):back page.

Book Review

Unlocking the Mysteries of Creation by Dennis Peterson
Master Books, Green Forest, AR. 2002, 240 pages, $33

Author Dennis Peterson has an active ministry giving creation seminars. This book is a new edition of the guide to his material. It includes in-depth background on many apologetics topics. The volume is beautifully done with attractive color pictures on nearly every page.

Since Dennis speaks to many people, one should be aware of certain controversial topics that are promoted. These include an unconventional “Lucas Model” for atoms (p. 19), the gospel in the stars (p. 198), and shrinking sun (p. 58). The idea of ozone depletion is strongly attacked (p. 38) with heavy reliance on the words of the late Dixy Lee Ray. Regarding the construction of ancient monuments such as the pyramids, there is the bizarre suggestion that ancients may have somehow levitated multi-ton limestone blocks into the air by using sound waves (p. 219).

There are excellent descriptions of design in nature. Examples include the firefly, hummingbird, giraffe, koala, seahorse, and hermit crab. These animals stories would make good devotions for children. Dennis often uses the *baloney detector* terminology of Phillip Johnson in seeking creation truth regarding evolution. Some of the topics highlighted are out-of-place artifacts found in rock strata, living fossils, and dinosaurs. Little space is given to the creation discussion of astronomy, stewardship, or the weather. A list of creation resources and web sites is included without any mention of the Creation Research Society which predates all the others. Nor are any CRS books or research articles referenced, even though they are the source of much of the included creation science data. Hopefully the CRS can be added in a future edition.

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The Uniformitarian Stratigraphic Column—Shortcut or Pitfall for Creation Geology?

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Abstract

The end of the twentieth century saw a substantial increase in theories attempting to explain natural history within a Biblical framework. The proliferation of divergent models has opened the door to healthy debate, but suggests that more clarity in the foundational issues of natural history would be beneficial for creationism. In the arena of stratigraphy, one of these issues is the role of the global uniformitarian stratigraphic column (hereafter referred to as "the column"): is it a springboard to accelerated progress or a quagmire? If the former, then it allows for the immediate development of mature Flood models. But we assert the inseparability between the column and evolution, uniformitarianism, and deep time. Therefore logic demands its separation from any Flood models. This caution is reinforced by the careless use of the column in some creationist models. Alternative approaches to defining stratigraphy within the Christian Worldview are needed and that work is underway.

Introduction

Creation science has come a long way since its modern revival with the issuance of *The Genesis Flood* (Whitcomb and Morris, 1961). Several creationist models and numerous less-integrated interpretations have been proposed, addressing the areas of tectonics and stratigraphy (Table I). But once the Biblical basics of Creation and the Flood are acknowledged, creationist models and interpretations tend to diverge significantly. This raises questions about the structure of creationist natural history and suggests that a consensus is needed on defining the questions, even if there is disagreement over the answers.

Of course, the present "frontier" nature of creationist research may be one reason for this diversity of thought. However, we believe that another reason is the paucity of thought about fundamental questions of natural history and stratigraphy. Investigation in this direction could foster agreement well beyond the Biblical text. At the root of the issue is the relationship between the limited detail provided in the Bible and empirical data that will presumably supply that deficiency. The fit between empirical data and Biblical truth is not simple, and the important question of *how* they fit is often unexplored and cannot be answered scientifically.

Assumptions and methods are always worth examining, and questions about them are never closed. If uniformitarian work is to be used, how much and what kind of modification is first needed? Do we use data only, or data and interpretation? If interpretation, how much? How can the two be distinguished? How do we deal with data selection forced by presuppositions or interpretation bias? What serves as an integrating framework for natural history models? Until sound answers to these questions are consistently applied, we are convinced that creationist models using uniformitarian interpretation will enjoy limited success. Why? One reason is that these models of earth history are developed within the context of the Naturalist worldview and are thus at odds with Christianity on many levels. We believe there are significant differences between a radical approach of evaluating and reinterpreting data collected, analyzed, and published over many years by the uniformitarian establishment and introducing a "Flood explanation" on top of an essentially uniformitarian interpretation.

Natural history is first and foremost *history*. It must be undergirded and framed by theological and philosophical justifications. Science, in a forensic sense, plays a secondary role, and must function in a mixed question approach (Reed, 2001). This is quite distinct from Naturalism, where science and natural history are considered synonymous (Cleland, 2001). But creationists should understand that confidence in historical reconstructions is quite different from that derived from experimental science. Apart from the consideration of specific historical events de-

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Table I. Creationist Models Addressing Global Tectonism and Stratigraphy

Originator and Date	Model or Development
Whitcomb and Morris, 1961	Posited Genesis Flood as cause of majority of rock record
Brown, 1980	Hydroplate Theory
Woodmorappe, 1983	TAB—Tectonically-Associated Biological Provinces
Austin, 1994; Austin and Wise, 1994	Integrated compressed Column
Walker, 1994A	Bible-based Stratigraphic Timescale
Austin et al., 1994; Baumgardner, 1986, 1990, 1994a, 1994b	Catastrophic Plate Tectonics
Froede, 1995, 1998A	Bible-based Stratigraphic Timescale
Reed et al., 1996	Proposed energy instead of time as stratigraphic key
Robinson, 1996	Advocated compressed column
Holt, 1996	Advocated compressed column
Gentet, 2000a	Creation, Curse, Catastrophe Model
Oard, 2001a, 2001b	Vertical Tectonics

scribed in Genesis, creationist natural history, and the nature and role of stratigraphy will differ in significant fashion from that practiced by Naturalism by virtue of profound differences in presuppositions and methods.

Thus, creationist stratigraphic models can fail by not discerning the "interbedding" of uniformitarian interpretation with data. The difficulty of separating the "data" from the "story" is enhanced by their merger in current technical literature—a situation probably related to the undue confidence Naturalists place in their historical reconstructions. Where creationists are not diligent to distinguish between data and interpretation, we leave ourselves open to being duped. When we seek to use uniformitarian data, we must beware of embedded assumptions and hidden layers of interpretation in the final presentation. It is easier to discern between data and interpretation if we are aware of the role of uniformitarianism as the historiographic framework of the Naturalist worldview.

In stratigraphy, a major issue is the use of the uniformitarian geologic column in creationist models. We believe that creationists incorporating the column will inevitably fail; but other creationists disagree. We propose an objective solution. *If it can be shown that the column rests, even in its supposedly empirical aspects, on presuppositions of evolution, uniformitarianism, and deep time, all inimical to creationism, then its role in creationist models should be discontinued.* If empirical aspects of the column are independent of those fundamental theological errors, then its use can provide a significant shortcut to fruitful work by creationists. We will examine the arguments, pro and con, for the role of the column in creationist stratigraphy; examine issues raised by its varied application in two creationist models, and discuss reasonable alternatives.

The Rock Record versus the Geologic Column

Before a discussion of the use of the column can be profitable, a distinction must be drawn between the "rock record" and the "geologic column." Many treat them as synonyms, when in fact they are not. "Rock record" is a descriptive term for those portions of the earth's crust open to human perception. Even the term carries historiographic baggage. Embedded within is the assumption that historical truth can be derived from examination of the rocks. Creationists and Naturalists agree that this is possible, but the methods and conclusions differ, because Naturalists 1) reject revelation, 2) do not manage uncertainty well, and 3) do little to distinguish between the perceptual rock record and the conceptual geologic column. Most geologists are so accustomed to overlaying the construct on local data, that little thought is given to its testing. It is simply applied.

However, the geologic column is more than just a descriptive compilation; it is an idealized representation of the crust as it would be absent erosion and nondeposition. It includes a historical framework not found in the physical description of the rocks themselves; a definite, linear historical sequence, absolute ages, tectonic history, paleoenvironmental interpretation, and even an account of geomagnetic fluctuations through time. The distinction between the rock record and the column is crucial for creationists parsing the uniformitarian literature. Any statement that contains historical propositions is by definition interpretive to some degree (Reed, 2001).

The Role of Stratigraphy

The definition of stratigraphy reads as follows:

> The science of rock strata. It is concerned not only with the original succession and age relations of rock strata but also with their form, distribution, lithologic composition [*lithostratigraphy*], fossil content [*biostratigraphy*], geophysical and geochemical properties – indeed, with all characters and attributes of rock as strata; and their interpretation in terms of environment or mode of origin, and geologic history (Bates and Jackson, 1987, p. 649). [Brackets added]

The definition of lithostratigraphy reads as follows:

> The element of stratigraphy that deals with the lithology of strata and with their organization into

> units based on lithologic character (Bates and Jackson, 1987, p. 385).

However, lithostratigraphy depends on the assumption of superposition (i.e., one layer stacked over another) and continuity to define age relations between strata. Recent work has shown that even those assumptions can be questioned empirically (Berthault, 2000). Lithostratigraphy cannot provide accurate or widespread age relations between rocks. The definition of biostratigraphy reads as follows:

> Stratigraphy based on the paleontologic aspects of rocks, or stratigraphy with paleontologic methods; specif. the separation and differentiation of rock units on the basis of the description and study of the fossils they contain (Bates and Jackson, 1987, p. 71).

Biostratigraphy simply follows the evolutionary model, which assumes that fossils were not transported great distances and that the sediment which encloses them is of the same age as the fossil. Neither of these assumptions is likely in any Flood model. Conventional biostratigraphy would argue that a comparison of similar clam fossils in the southeastern United States with those found in Great Britain would require both similar paleoenvironment and age. But outside of evolution, there is no meaningful way, in the context of the Flood, for fossil comparisons to provide global correlative ages.

The incompatibility of conventional stratigraphy with any Flood scenario and the necessary distinction between the rock record and the geologic column illustrate the extent to which modern stratigraphy requires reevaluation. Klevberg (1999; 2000a) provided a good introduction to both philosophical and scientific challenges facing creationist stratigraphy. Since stratigraphy is at the heart of modern natural history, it will be difficult to replace stratigraphy without rebuilding most of natural history. If creationist answers to these basic issues force interpretation sharply away from present uniformitarian dogma on a broad front, then we must accept that and move forward into the uncharted territory of a comprehensive and self-consistent creationist stratigraphy. But not everyone agrees with this assessment.

Adopt Portions of the Column: Pro

Following a meeting held at Bolney House, Sussex, England in August 1996, several young-earth geoscientists issued a statement outlining their position regarding the use of the global uniformitarian stratigraphic column in natural history (Snelling, Ernst, Scheven, Austin, Wise, Garner, Garton, and Tyler, 1996). The group stated that while the entire construct of the column was unacceptable, portions could be extracted (specifically the biostratigraphic and lithostratigraphic components) to provide a ready-made framework for natural history models in creationism. They asserted that the column was an empirical compendium of outcrops and subsurface data and that its time periods could be transposed in the same sequence to form a creationist framework. Obviously the absolute time scale would be dramatically compressed.

Publication of this position postdates its application. It reflects the position of work conducted in the Grand Canyon (Austin, 1994) and the Eastern Mojave Desert (Austin and Wise, 1994). The biostratigraphic and lithostratigraphic portions of the uniformitarian stratigraphic column were used to define the Flood/pre-Flood boundary. Other creationists have also followed the general framework of the uniformitarian column in an effort to adopt their concepts of the Flood to the global stratigraphic construct (e.g., Holt, 1996; Morris, 1996).

Several individuals from the Bolney House group presented their stratigraphic concepts using the bio- and lithostratigraphic portions of the column in a special symposium of the *Creation Ex Nihilo Technical Journal* (Garner, 1996a, 1996b; Garton, 1996; Robinson, 1996; Snelling, 1997; Tyler, 1996). Their adoption of the column coincided with a desire to drive “golden spikes” at the pre- and post-Flood boundaries. However, to preserve the integrity of the “stripped down” column, they had to invoke multiple global catastrophes apart from the Flood to explain the various “Periods” and “Eras” that did not fit the traditional understanding of the Flood having caused most of the rock record.

Use of the column as a creationist stratigraphic framework was advocated by this group because: 1) it supposedly represents an empirically-derived ideal relative age scale of crustal lithology, 2) it allows the global correlation of strata, and 3) it provides a tremendous shortcut to deriving creationist alternatives based on exhaustive local studies and subsequent integration. Given the size of the creationist geological community, taking leaps forward instead of small steps appears as an attractive alternative to the work involved otherwise. But is it a leap forward or back?

Adopt Portions of the Column: Con

Following the special Flood/post-Flood symposium and the Bolney House statement, several articles were presented by individuals who opposed using the column to define Flood geology (Oard, 1996; Woodmorappe, 1996, 1999a; Froede, 1997). Woodmorappe’s contribution must be seen in the context of his earlier work (Woodmorappe, 1981) arguing against the existence of the column at all (an argument that remains compelling in our opinion).

The spate of publications discussing the placement of pre-Flood and post-Flood stratigraphic boundaries in the new, compressed “creationist” column sparked a negative test of its effectiveness in defining a Flood/post-Flood boundary in the Gulf of Mexico Basin (Froede and Reed, 1999). After testing several proposed boundaries in the column, we determined that none appeared appropriate, and further concluded the failure to identify *any* feasible boundary (coinciding isochronally with the column) suggested that the adoption of the column was itself the problem. Tyler and Garner (2000) protested that conclusion, but we reiterated that the column did not aid Flood interpretation of the Gulf of Mexico geology (Reed and Froede, 2000). We leave it to the interested reader to draw his own conclusions from our work and subsequent comment.

That exchange is relevant because it raised several key arguments against the use of the column in creationist stratigraphy. These can be summarized as: 1) evolution is a necessary condition of the column, 2) uniformitarianism is a foundation of the column, and 3) absolute time compression is not as simple as it first appears, and does not resolve the differences between the old-earth and young-earth frameworks.

The relationship between evolution and the column is stated unambiguously by the North American Stratigraphic Code. The code states (1983, p. 849):

> Biologic remains contained in, or forming, strata are uniquely important in stratigraphic practice. First, they provide the means of defining and recognizing material units based on fossil content (biostratigraphic units). Second, the irreversibility of organic evolution makes it possible to partition enclosing strata temporally. Third, biologic remains provide important data for the reconstruction of ancient environments of deposition.

Stephen Jay Gould (1997, pp. 157–158) expanded on the problem addressed by the writers of the stratigraphic code:

> A chronometer of history has one, and only one, rigid requirement—something must be found that changes in a recognizable and irreversible way through time, so that each historical moment bears a distinctive signature. Geologists have long appreciated this principle in the abstract, but had not found a workable criterion… Moreover, rocks are simple physical objects formed by chemical laws and, as such, do not bear distinctive temporal signatures. Quartz is quartz—conjoined tetrahedra with a silicon ion in the center, surrounded by four oxygen ions, each shared with a neighboring tetrahedron. So it was in the beginning and is now, and ever shall be so long as nature's laws prevail. Cambrian quartz is not different from Pleistocene quartz.
>
> But life is complex enough to change through a series of unrepeated states. *Today we attribute this irreversible sequence to the workings of evolution…* [emphasis added]

The essence of natural history, captured by the column, is the working of evolution that provides a strand to follow events inferred from the rock record. Although some argue that Darwin's publication of his theory of evolution postdates the geologic column, it is clear that evolution has a much longer history (Morris, 2000), especially in the Enlightenment context that produced its 19th Century proponents. For example, Diderot (1713–1784), the influential French thinker, accepted "Transformism," and Lamarck (1744–1829) heavily influenced Lyell (Barzun, 2000). Gould (1997) also admits that 19th century geology, dominated by the views of Hutton and Lyell, included biologic views of progress, common when Lyell published his *Principles* between 1830 and 1833. So evolution is part and parcel of the column.

Evolution directs the erecting of the walls, but the foundation is uniformitarianism. The assumption that the rock record represents a global, time-correlative, representative snapshot of natural history demands it. Otherwise, global correlation of "same age" rocks would be impossible, since different depositional processes are expected to exist at the same time at different places around the globe. Uniformitarianism's necessity is clearly seen in the assumption that ancient environments of deposition can be reconstructed using modern analogs. Since we understand uniformitarianism to be the historiographic presupposition of Naturalism (Reed, 2001), it is only proper to consider it in opposition to a Biblical understanding of history. The later part of the 20th Century saw the victory of a new, "dilute" version of uniformitarianism, quite different from Lyell's original. Although the new version allows more flexibility in interpreting depositional environments and processes, it only does so at a hidden price. Consider that uniformitarians universally acknowledge the absence of the vast majority of the rock record. With so much of the empirical evidence gone, logic demands an inversely strict uniformitarianism to further restrict uncertainty and provide some confidence in historical interpretation.

The claim that the column can be "fixed" by shrinking the absolute time scale is quite attractive, and that attraction may help mask the complexities of doing so. It is thought that the only modification needed is a "simple" compression of the absolute time scale from 4,500,000,000 years to less than 10,000 years. But is this change quite so simple? If I take a new car and run it through a hydraulic press I can compress it. It may then be a car and it may be compressed, but will it work? Compressing the timescale of the geologic column is not as simple as it might appear because the time-rock-environment interpretative framework is designed for *uniformitarian* depositional conditions. Thus, the issue is not time *per se*, but the mode of deposition (uniformitarianism versus catastrophism) and preservation (evolution versus extinction).

Because of these different modes (i.e., catastrophism vs. uniformitarianism), the proposed time compression cannot be uniform. There can be no one-to-one correlation of X million years on the column to X thousand years on its creationist analog. There is no correspondence between the vast majority of the rock record being deposited by processes operating today over incredibly vast periods of time, and a much shorter "uniform" history punctuated by a one-year catastrophe. In the former, there is uniformity in the processes producing the rock record; in the latter there is not.

So, as we argued earlier (Reed et al., 1996), time is not even an *appropriate* integrating factor in Flood stratigraphy at all. Consider; the mass of the rock record was deposited rapidly and probably at varying rates in different locations. How then can strata be considered globally correlative in a time-stratigraphic sense? Diachronous sedimentation, not a problem when the time scale is in millions of years, is a tremendous challenge for Flood geologists intent on a time-stratigraphic interpretation. Instead of trying to parse hours and days of depositional processes in a Flood setting, we advocate the abandonment of time as the heart of stratigraphy. We believe that depositional processes and their relative energy levels are a better key to interpretation. However, we recognize that other factors may be equally valid or even superior, and that question is worthy of further debate among creationists.

In spite of these difficulties, the willingness of young-earth creationists to utilize the column in their models remains undiminished. If the arguments in favor of the column are demonstrated to be superior, then those models can proceed to be tested in other ways. However, if not, then the models will have been proven to have failed at their points of contact with the column even prior to other tests.

Models Incorporating the Column

Two models, the recently-introduced Creation/Curse/Catastrophe (CCC) model and the Catastrophic Plate Tectonics (CPT) model, demonstrate pitfalls in creationists' use of the column. CPT has been extant since at least 1994, but has been the focus of a recent dialogue in the *Creation Ex Nihilo Technical Journal*. In contrast to the efforts of the Bolney House Group, neither model appears to have carefully considered their adoption of the column. The CCC model eviscerates its essential time-stratigraphic function, while keeping the shell, presumably for its reputation as an interpretive framework. The CPT model relies on the column to justify lines of evidence borrowed from its uniformitarian parent without carefully identifying or sorting those aspects of the column and evidences for plate tectonics that are derived from and upheld by uniformitarian interpretation. Neither model addresses the evolutionary and uniformitarian links in the column, nor do they present arguments demonstrating how the column can be used in a creationist framework.

The Creation/Curse/Catastrophe Model

The CCC model (Gentet, 2000a; 2000b) proposes that most of the geologic record is a result of extra-Flood catastrophes associated with the divine curse of Genesis 3. The model appears to accept the column as a framework of correlation and description of the global rock record, but closer evaluation reveals that the essential time-stratigraphic structure of the column has been overturned in favor of a paleoenvironmental interpretation. Instead of the geologic periods representing time-stratigraphic divisions, the Phanerozoic eras are said to represent preserved distinct ecosystems, resulting from the work of the 3rd, 5th, and 6th days of creation.

The introduction of this model has raised many questions (Akridge, 2000a; Froede, 2000a; Klevberg, 2000b; Reed, 2000a; Woodmorappe, 2000). An issue common to all was the curiosity over the sudden disappearance of the Flood from "Flood geology." Gentet's reply (2000b) and subsequent letters by supporters (Aufdemberge, 2001; Lain, 2001) failed to address this revolutionary change. Critics likened the CCC model to the "tranquil Flood" theory, not because it explicitly advocated a tranquil Flood, but because the contention that the Flood would not have left significant geologic evidence above and beyond an erosion surface seemed identical in terms of field investigation. The continuity of the "creation ecosystems" before and after the Flood also needs to be reconciled with textural evidence regarding the alteration of the earth's surface by the destructive power of the Flood (Genesis 6:13, II Peter 3:6).

Although the CCC model is correct in its insistence on an explicit Biblical foundation, we believe that it employs improper exegesis and goes well beyond the bounds of the Biblical text. We find no textural reason for assuming that the curse of Genesis 3, with specific penalties described in that chapter, provides a basis for global natural catastrophes *prior* to the Flood. We invite Biblical scholars and theologians to carefully examine these aspects and publish their findings in the *Quarterly*.

However, our immediate interest with CCC model is its unique utilization of the column. It is interesting that the CCC model abandons the fundamental time-stratigraphic nature of the column without seriously questioning its relationship to evolution, uniformitarianism, and deep time. It simply seems to automatically assume that the column accurately captures a rock record that accurately reflects the three paleoenvironments (Paleozoic, Mesozoic, and Cenozoic) buried *before* the global Flood, but neglects to discuss why there is any need to retain *any* of the column after jettisoning its basic structure. Uniformitarian geoscientists clearly understand the limited nature of the column in accurately defining past paleoenvironments (Ager, 1993a; 1993b; Braunstein, 1974; Hallam, 1981; Reading, 1996; Selley, 1985; Walker and James, 1992). It is puzzling that the advocates of the CCC model do not see this conflict. We hope that further explanation of the handling of the column in the CCC model will be forthcoming.

The Catastrophic Plate Tectonic Model

Catastrophic Plate Tectonics (Austin et al., 1994) grew out of discussions about the role of plate tectonic theory in creation geology. The central concept of runaway subduction and subsequent accelerated plate motion arose from computer modeling studies (Baumgardner, 1986, 1990, 1994a, 1994b). It was deemed that a simple time compression (similar to the modification of the column) was sufficient to allow CPT to piggyback onto the evidence for its uniformitarian parent (Snelling, 1995). Questions about this arrangement were raised (Reed et al., 1996; Reed, 2000c), but have been ignored until a dialog sponsored by the *Creation Ex Nihilo Technical Journal* (TJ Editors, 2002; Oard, 2002a; 2002b; 2002c; Baumgardner, 2002a; 2002b; 2002c). Many issues related to both catastrophic and uniformitarian plate tectonics were discussed, but the issue that attracts our attention here is the manner in which CPT utilizes the column. It illustrates concerns mentioned earlier about distinguishing between data and interpretation.

CPT relies on the column to validate *interpretations* that are in turn presented as data. For example, Baumgardner (2002) states that the regularly decreasing age of the seafloor from the midocean ridges to the continents is a key piece of evidence for CPT. However, the conclusion of this age distribution rests in part on the application of the column and its dating scheme to seafloor sediments. Baumgardner (2002) applies relative dating comparisons based on microfossil assemblages. But these assemblages are assigned their relative ages based on their evolutionary succession!

Plate tectonic theory illustrates why the “simple” compression of the absolute time scale of the column does not resolve problems in migrating from an old-earth uniformitarian framework to a young-earth catastrophic alternative. One problem is the inability to resolve even the *relative* timing of uniformitarian plate tectonic events with the sequence demanded by the Genesis Flood. For example, uniformitarian plate tectonics is an ongoing process with *repeated* continental joining and separation (Froede, 2000b; Hoffman, 1988; Rogers, 1996; Windley, 1993). CPT appears to include only one catastrophic episode of plate motion and subduction, followed by quiescence (Baumgardner, 2002a; 2002b; 2002c).

Alternate Approaches to Creationist Stratigraphy

While the desire to incorporate the column into creationist stratigraphy is present, the necessity is not. Creationists have proposed other stratigraphic approaches. An early, exhaustive evaluation of the distribution of fossils by Woodmorappe (1983) led to the development of his “TAB” model—TAB standing for “tectonically-associated biological provinces.” In 1994, Walker presented a stratigraphic model at the Third International Creation Conference. His model proposed a framework for defining strata on a timeline extracted from the Bible. He applied his model at locations in Australia (1996a; 1996b) and New Zealand (2001). Froede (1995) published a similar timescale, based on events described in Genesis and Job. This timescale was used for comparison in an evaluation of the column in the Gulf of Mexico basin (1999). Reed, Froede, and Bennett (1996) advocated geologic energy as the integrating factor in creationist stratigraphy.

Theoretical alternatives have been complemented by field studies that have ignored the column. Akridge (1998; 2000b) and Akridge and Froede (2000) described and interpreted strata found in the area around Lookout Mountain (NE Alabama-NW Georgia border) with reference to the Genesis Flood without relying on the column. Interpretation outside the column was also applied to gravel deposits found in Montana and sections of Canada (Klevberg, 1998; Klevberg and Oard, 1998; Oard and Klevberg, 1998). Reed (2000b) described and interpreted strata associated with the North American Midcontinent Rift System with respect to depositional energy levels rather than the column. Reed (2002) applied the same method at the Palo Duro Basin, Texas.

Conclusion

The uniformitarian stratigraphic column encapsulates the modern geologic interpretation of the earth’s crust. Unfortunately, that interpretation includes the rejection of the Christian worldview in favor of Naturalism—a worldview that replaces a reality founded on God’s Creation and governance of the universe with an impersonal, uncaring mechanism. It also substitutes Christianity’s confidence in a truth granted by God’s revelation with an unstable positivism that succeeds only when it pilfers Christian doctrine. Finally, it sterilizes a meaningful and rich history, substituting a timeframe designed to dismiss the immanent presence of the Creator, and fills its endless ages with pseudo-scientific "just-so" stories. When we consider the vast chasm that lies between Naturalism and Christianity, we do not see how creationists can escape the necessity of razing that worldview until no two stones are left standing, and then rebuilding natural history and its derivative stratigraphy from the ground up.

Creationist proponents of adopting the stratigraphic column believe that they are simply incorporating an empirical construct without any stain of Naturalism. We are confident that they decry any influence of Naturalism in creationism and gladly eschew its tenets. However, we fear that they are missing connections between the column and that worldview and we challenge them to examine more closely the assumptions, methods, and conclusions that surround the column. We hope that they come to see the difference between the perceptual and conceptual. If it quacks like a duck…

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References

CRSQ: Creation Research Society Quarterly
CENTJ: Creation Ex Nihilo Technical Journal

Ager, D.V. 1993a. *The nature of the stratigraphical record*. Third edition. John Wiley and Sons, New York.

___. 1993b. *The new catastrophism: The importance of the rare event in geological history*. Cambridge University Press, New York.

Akridge, A.J. 1998. A Flood-based origin of Little River Canyon near Ft. Payne, Alabama. In Walsh, R.E. (Editor). *Proceedings of the Fourth International Conference on Creationism*. Technical Symposium Sessions. pp. 9-20. Creation Science Fellowship, Pittsburgh, PA.

———.. 2000a. CCC issues. *CRSQ* 37:202-203.

———. 2000b. DeSoto Falls in DeSoto State Park, Alabama: Evidence for recent formation? *CRSQ* 36:170-176.

Akridge, A.J., and C.R. Froede, Jr. 2000. Rock spires (pseudo-hoodoos) on the Lookout Mountain Syncline. *CRSQ* 36:216-220.

Aufdemberge, T. 2001. CCC model—An opinion. *CRSQ* 38:110.

Austin, S.A. (Editor). 1994. *Grand Canyon: Monument to catastrophe*. Institute for Creation Research, Santee, CA.

Austin, S.A., J.R. Baumgardner, D.R. Humphreys, A.A. Snelling, L. Vardiman, and K.P. Wise. 1994. Catastrophic plate tectonics: A global Flood model of Earth history. In Walsh, R.E. (editor). *Proceedings of the Third International Conference on Creationism*. Technical Symposium Sessions. pp. 609-621. Creation Science Fellowship, Pittsburgh, PA.

Austin, S.A. and K.P. Wise. 1994. The pre-Flood/Flood boundary: As defined in Grand Canyon, Arizona and Eastern Mojave Desert, California. In Walsh, R.E. (editor). *Proceedings of the Third International Conference on Creationism*. Technical Symposium Sessions. pp. 37-47. Creation Science Fellowship, Pittsburgh, PA.

Barzun, J. 2000. *From dawn to decadence: 500 years of western cultural life*. Harper Collins, New York.

Bates, R.L. and J.A. Jackson. 1987. (Editors). *Glossary of geology*. Third edition. American Geological Institute, Alexandria, VA.

Baumgardner, J. R. 1986. Numerical simulation of the large-scale tectonic changes accompanying the Flood. In Walsh, R.E., C.L. Brooks, and R.S. Crowell (editors). *Proceedings of the First International Conference on Creationism*. Volume II. Technical Symposium Sessions and Additional Topics. pp. 17-30. Creation Science Fellowship, Pittsburgh, PA.

———. *1990. 3-D finite element simulation of the global tectonic changes accompanying Noah's Flood. In Walsh, R.E. and C.L. Brooks (editors). Proceedings of the Second International Conference on Creationism*. Volume II. Technical Symposium Sessions and Additional Topics. pp. 35-45. Creation Science Fellowship, Pittsburgh, PA.

———.. 1994a. Computer modeling of the large-scale tectonics associated with the Genesis Flood. In Walsh, R.E. (editor). *Proceedings of the Third International Conference on Creationism*. Technical Symposium Sessions. pp. 49-62. Creation Science Fellowship, Pittsburgh, PA.

———. 1994b. Runaway subduction as the driving mechanism for the Genesis Flood. In Walsh, R.E. (editor). *Proceedings of the Third International Conference on Creationism*. Technical Symposium Sessions. pp. 63-75. Creation Science Fellowship, Pittsburgh, PA.

———. 2002a. Catastrophic plate tectonics: the geophysical context of the Genesis Flood. *CENTJ* 16(1):58-63.

———. 2002b. Dealing carefully with the data. *CENTJ* 16(1):68-72.

———. 2002c. A constructive quest for truth. *CENTJ* 16(1):78-81.

Berthault, G. 2000. Geological dating principles questioned. English translation from *Fusion* 81, mai-juin 2000, Editions Alcuin, Paris.

Braunstein, J. (Compiler). 1974. *Facies and the reconstruction of environments*. American Association of Petroleum Geologists Reprint Series Number 10. American Association of Petroleum Geologists, Tulsa, OK.

Brown, W. 2001. *In the beginning: Compelling evidence for Creation and the Flood*. Seventh edition. Center for Scientific Creation, Phoenix, AZ.

Cleland, C.E. 2001. Historical science, experimental science, and the scientific method. Geology 29(11):987-990.

Coffin, H. 1983. *Origin by design*. Review and Herald Publishing Association, Washington, D.C.

Froede, C.R., Jr. 1995. A proposal for a creationist geological timescale. *CRSQ* 32:90-94.

———. 1997. The global stratigraphic record. *CENTJ* 11(1):40-43.

———. 1998. *Field studies in catastrophic geology*. Creation Research Society Books, St. Joseph, MO.

———. 2000a. CCC issues. *CRSQ* 37:199-200.

———. 2000b. Questions regarding the Wilson cycle in Plate Tectonics and Catastrophic Plate Tectonics. In Reed, J.K. (Editor). *Plate Tectonics: A different view*. pp. 147-157. Creation Research Society Books, St. Joseph, MO.

Froede, C.R., Jr., and J.K. Reed. 1999. Assessing creationist stratigraphy with evidence from the Gulf of Mexico. *CRSQ* 36:51-60.

Garner, P. 1996a. Where is the Flood/post-Flood boundary? Implications of dinosaur nests in the Mesozoic. *CENTJ* 10(1):101-106.

———. 1996b. Continental flood basalts indicate a pre-Mesozoic Flood/post-Flood boundary. *CENTJ* 10(1):114-127.

Garton, M. 1996. The pattern of fossil tracks in the geological record. *CENTJ* 10(1):82-100.

Gentet, R.E. 2000a. The CCC model and its geologic implications. *CRSQ* 37:10-21.

———. 2000b. The CCC model: A reply to Froede, Reed, Akridge, Woodmorappe, Klevberg. *CRSQ* 37:207.

Gould, S. J. 1997. *Time's arrow time's cycle: Myth and metaphor in the discovery of deep geological time*. Harvard University Press, Cambridge MA.

Hallam, A. 1981. *Facies interpretation and the stratigraphic record*. W.H. Freeman, San Francisco, CA.

Hoffman, P.F. 1988. United plates of America, the birth of a craton: Early Proterozoic assembly and growth of Laurentia. *Annual Review of Earth and Planetary Sciences* 16:543-603.

Holt, R.D. 1996. Evidence for a late Cainozoic Flood/post-Flood boundary. *CENTJ* 10(1):128-167.

Klevberg, P. 2000a. The philosophy of sequence stratigraphy Part II – application to stratigraphy. *CRSQ* 37(1):36-46.

———. 2000b. CCC issues. *CRSQ* 37:204-206.

———. 1999. The philosophy of sequence stratigraphy Part I–philosophic background. *CRSQ* 36(2):72-80.

———. 1998. The Big Sky Paving Gravel Deposit, Cascade County, Montana. *CRSQ* 34:225-235.

Klevberg, P., and M.J. Oard. 1998. Paleohydrology of the Cypress Hills Formation and Flaxville Gravel. In Walsh, R.E. (Editor). *Proceedings of the Fourth International Conference on Creationism*. Technical Symposium Sessions. pp. 361-378. Creation Science Fellowship, Pittsburgh, PA.

Lain, E.C. 2001. Defense of CCC model. *CRSQ* 38:165-168.

Morris, H.M. 1996. The geologic column and the Flood of Genesis. *CRSQ* 33:49-57.

———. 2000. *The long war against God: the history and impact of the creation/evolution conflict*. Master Books, Green Forrest, AR.

North American Commission on Stratigraphic Nomenclature. 1983. North American Stratigraphic Code. *American Association of Petroleum Geologists Bulletin* 67(5):841-875.

Oard, M.J. 1996. Where is the Flood/post-Flood boundary in the rock record? *CENTJ* 10(2):258-278.

———. 2002a. Is catastrophic plate tectonics part of earth history? *CENTJ* 16(1):64-68.

———. 2002b. Does the catastrophic plate tectonics model assume too much uniformitarianism? *CENTJ* 16(1):73-77.

———. 2002c. Dealing carefully with the *data*. *CENTJ* 16(1):82-85.

Oard, M.J., and P. Klevberg. 1998. A diluvial interpretation of the Cypress Hills Formation, Flaxville Gravel, and related deposits. In Walsh, R.E. (Editor). *Proceedings of the Fourth International Conference on Creationism*. Technical Symposium Sessions. pp. 421-436. Creation Science Fellowship, Pittsburgh, PA.

Reading, H.G. 1996. (Editor). *Sedimentary environments: Processes, facies, and stratigraphy*. Third edition. Blackwell Science, Cambridge, MA.

Reed, J.K.. 2000a. CCC issues - letter to the editor. *CRSQ* 37:200-202.

———. 2000b. *The North American Midcontinent Rift System: An interpretation Within the Biblical Worldview*. Creation Research Society Books, St. Joseph, MO.

———. Editor. 2000c. *Plate tectonics: a different view*. Creation Research Society Books, St. Joseph, MO.

———. 2001. *Natural history in the Christian worldview: Foundation and framework*. Creation Research Society Books, St. Joseph, MO.

———. 2002. Reinventing stratigraphy at the Palo Duro Basin. *CRSQ* 39:25-39.

Reed, J.K., and C.R. Froede, Jr. 2000. Bible-based Flood geology: Two different approaches to resolving Earth history–A reply to Tyler and Garner. *CRSQ* 37:61-66.

Reed, J.K., C.R. Froede, Jr., and C.B. Bennett. 1996. The role of geologic energy in interpreting the stratigraphic record. *CRSQ* 33:97-101.

Reed, J.K., C.B. Bennett, C.R. Froede, Jr., M.J. Oard, J. Woodmorappe. 1996. An introduction to modern uniformitarian and catastrophic plate tectonic concepts. *CRSQ* 33:202-210.

Robinson, S.J. 1996. Can Flood geology explain the fossil record? *CENJT* 10(1):32-69.

Rogers, J.J.W. 1996. A history of continents in the past three billion years. *Journal of Geology* 104:91-107.

Selley, R.C. 1985. *Ancient sedimentary environments*. Third edition. Cornell University Press, Ithaca, N.Y.

Snelling, A.A. 1995. Plate tectonics: Have the continents really moved apart? *CENTJ* 9(1)12-20.

___. 1997. The editor comments... *CENTJ* 11(1):44-45.

Snelling, A.A., M. Ernst, E. Scheven, J. Scheven, S.A. Austin, K.P. Wise, P. Garner, M. Garton, and D. Tyler. 1996. The geological record. *CENTJ* 10(3):333-334.

TJ Editors. 2002. Forum on catastrophic plate tectonics. *CENTJ* 16(1):57.

Tyler, D.J. 1996. A post-Flood solution to the chalk problem. *CENTJ* 10(1):107-113.

Tyler, D.J., and P. Garner. 2000. The uniformitarian column and Flood geology: A reply to Froede and Reed (1999, *CRSQ* 36:51-60). *CRSQ* 37:60-61.

Walker, R.G., and N.P. James. 1992. (Editors). *Facies models: Response to sea level change*. Geological Association of Canada, St. John's, Newfoundland, Canada.

Walker, T. 1994. A Biblical geologic model. In Walsh, R.E. (Editor). *Proceedings of the Third International Conference on Creationism*. Technical Symposium Sessions. pp. 581-592. Creation Science Fellowship, Pittsburgh, PA.

———. 1996a. The basement rocks of the Brisbane area, Australia: Where do they fit in the creation model? *CENTJ* 10(2):241-257.

———. 1996b. The Great Artesian Basin, Australian. *CENTJ* 10(3):379-390.

———. 2001. Post-Flood volcanism on the Banks Peninsula, New Zealand. *CENTJ* 15(1):96-104.

Whitcomb, J.C., and H.M. Morris. 1961. *The Genesis Flood*. Baker Book House, Grand Rapids, MI.

Windley, B.F. 1993. Uniformitarianism today: Plate tectonics is the key to the past. *Journal of the Geological Society of London* 150:7-19.

Woodmorappe, J. 1981. The essential nonexistence of the evolutionary-uniformitarian geologic column: A quantitative assessment. *CRSQ* 18:46-71.

———. 1983. A Diluviological treatise on the stratigraphic separation of fossils. *CRSQ* 20:1133-185.

———. 1996. Studies in Flood geology: Clarifications related to the "reality" of the geological column. *CENTJ* 10(2):279-290.

———. 1999. The geologic column: Does it exist? *CENTJ* 13(2):77-82.

———. 2000. CCC issues. *CRSQ* 37:203-204.

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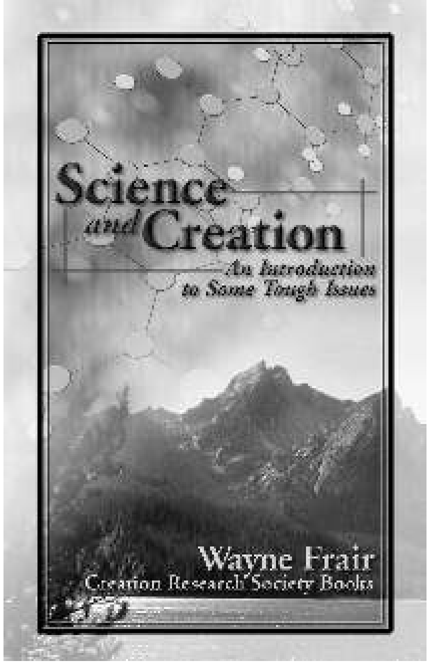
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Postdiluvial Soil Formation and the Question of Time
Part II—Time

Peter Klevberg and Richard Bandy*

Abstract

Many believe that most soils require great periods of time to form. This argument has been used in an attempt to refute the Bible's claims for a global flood only a few thousand years ago. In addition to arguments based on formation of extant soils, many geologists or paleopedologists see evidence of multiple fossil soil horizons or paleosols in the geologic record. Few, if any, of these researchers have examined carefully the assumptions behind their arguments. As described in Part I of this paper, pedogenesis is a complex phenomenon affected by several environmental factors. In Part II of this paper, we describe predictions of traditional and diluvial approaches to natural history and compare these predictions with constraints resulting from analysis of soil-forming mechanism rates. The results indicate that data from soil science are not only compatible with a diluvial view of earth history, but are actually more easily accommodated by it than by the traditional view.

Pedogenesis

Pedogenesis is the development of soil from geologic parent material. As described in Part I of this paper, pedogenesis is a complex phenomenon. Adding to the complexities of soil science are differences over the definition of soil and a reliance, particularly in the past, on the following:

- genetic definitions (historical, not scientific),
- definitions of soil-forming factors that include time both implicitly and explicitly,
- zonal definitions that fail to recognize interaction of soil-forming processes and geologic, geomorphic, or hydrologic factors.

Assumptions about earth history and the rates of soil-forming processes greatly affect one's view of pedogenesis, both in perceived rates of formation and the relative importance of environmental factors.

As described in Part I of this paper (Klevberg and Bandy, 2003), five *soil forming factors* are commonly accepted among soil scientists: climatic, parent material, topographic, biotic, and time.[1] Having noted the confusion introduced by having time itself as a soil forming factor, we have presented the idea of five *environmental factors* that influence soil formation. These environmental factors are mathematically described as partial derivatives *with respect to time*. The combination of environmental factors determines the rates of change of the actual *soil-forming mechanisms*. These environmental factors and soil-forming mechanisms are summarized below.

Environmental factors:

- Climatic (C): $\partial^2 S/\partial C \partial t$ = change in soil state over time due to climatic factor
- Parent Material (M): $\partial^2 S/\partial M \partial t$ = change in soil state over time due to parent material factor
- Geomorphic (G): $\partial^2 G/\partial B \partial t$ = change in soil state over time due to geomorphic factor
- Biotic (B): $\partial^2 S/\partial B \partial t$ = change in soil state over time due to biotic factor
- Ground Water (W): $\partial^2 S/\partial W \partial t$ = change in soil state over time due to ground water factor

The change in soil state caused by environmental factors is secondary via influence on soil-forming mechanisms.

Soil-forming mechanisms:

- Epigenesis (E): $\partial^2 S/\partial E \partial Mt$ = change in soil state over time due to epigenesis
- Physical weathering (P): $\partial^2 S/\partial P \partial t$ = change in soil state over time due to physical weathering

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[1] The first part of this series forms an essential foundation for this paper. Important terms that may be unfamiliar to some readers and were not included in the glossary of the first paper are included in a glossary near the end of this paper.

- Leaching (L): $\partial^2 S/\partial L \partial t$ = change in soil state over time due to leaching
- Organic matter (O): $\partial^2 S/\partial O \partial t$ = change in soil state over time due to organic matter

The change in soil state caused by soil-forming mechanisms is primary to pedogenesis.

Five soil orders often interpreted as requiring moderate to long periods of time to form are especially considered in this paper. Parts of the world where these orders are dominant are shown on Figure 1. The focus of this paper is rates of change in soil state due to soil-forming mechanisms for these soil orders and the influence of environmental factors on these rates based on disparate views of earth history.

Parametric Study of Pedogenic Processes

Because time is implicit in the common variables of pedogenesis, complexities abound in analyzing the parameters that influence the rates of soil formation. Because soil formation occurs in time, pedogenesis lies properly within the sphere of history, and science can deal with it only indirectly. Predictions of physical and chemical changes in soil formation are greatly influenced by the bias of observers based on their views of earth history. In general, these views can be categorized as but two: the establishment geologic paradigm (EGP), which generally holds to gradualism, naturalism, an ancient earth, and evolutionism; and the diluvial geologic paradigm (DGP), which holds to a relatively young earth, catastrophism, and biblical history. Variants that do not fit these stereotypes are relatively unimportant to the analysis of pedogenesis presented in this paper.

Soil History Predictions Based on View of Earth History

Because the EGP assumes the availability of long periods of time for soil formation, pedologists who subscribe to this view tend to assume that soil formation has been a slow, gradual process (Brady, 1974, p. 309; Harding, 2001; Natural Resource Conservation Service, 1997; Weaver, 1989, p. 106). Evolutionists will therefore tend to expect gradual or cyclic pedogenic processes. By contrast the DGP assumes a short time for earth history, the availability of vast amounts of energy within the year long global Flood cataclysm, and probable residual catastrophism. Diluvialists, while recognizing the influence of environmental factors on soil-forming mechanisms, place greater or lesser emphasis than their establishment counterparts on individual factors and assume that the rates at which environmental factors have operated may have varied greatly in the past. Rates and types of soil formation would thus have also var-

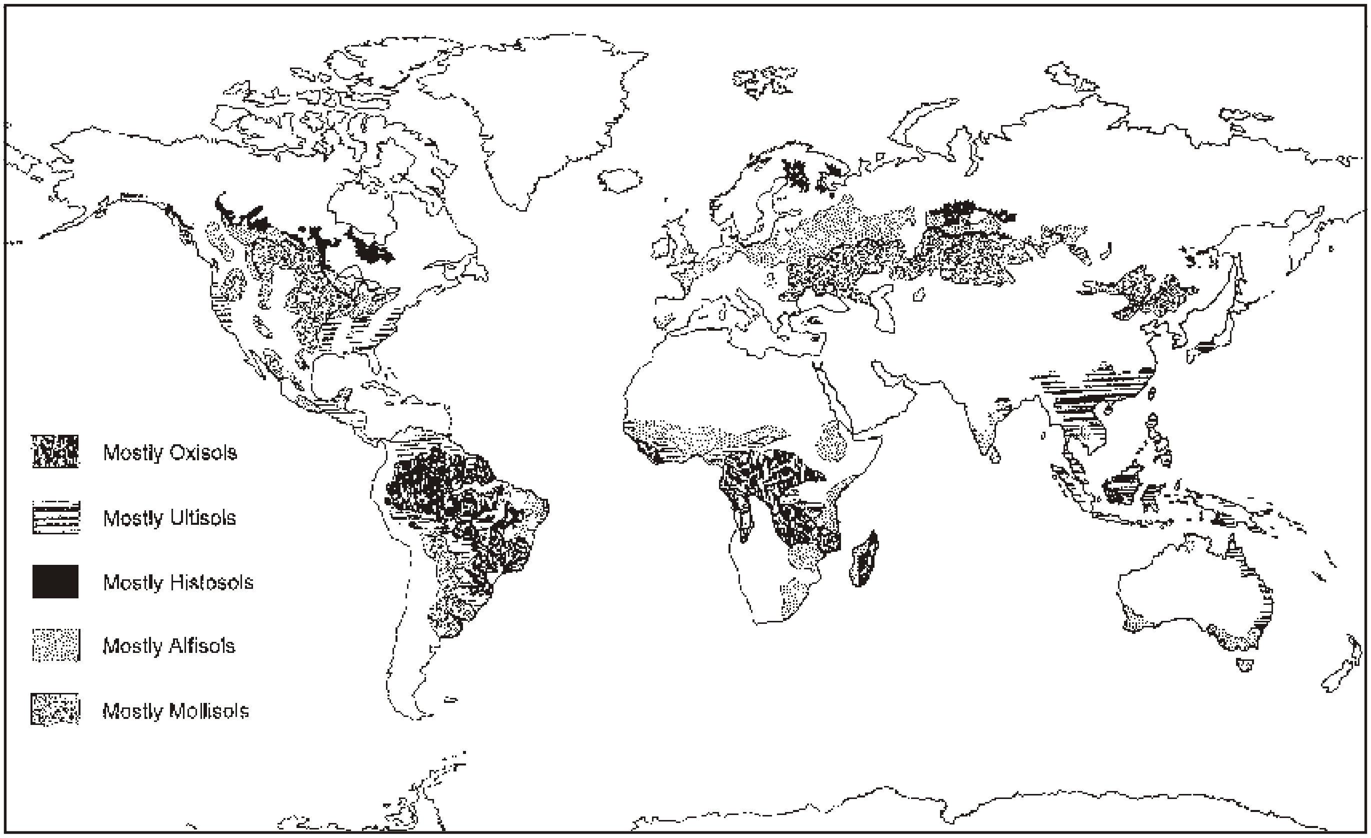

Figure 1. Dominant Soil Orders of the World (data from Brady, 1974, and U.S.D.A. files).

ied greatly in the past and may have been significantly different from the present. According to the DGP, many soils can be expected to have complex histories.

EGP Expectations

- Climate has exerted its influence on pedogenesis over vast periods of time, and climate change has tended to be gradual throughout earth history, allowing the soil to often reach or approach equilibrium with its environment (Brady, 1974, pp. 303,309; Selley, 1976, p. 55; Weaver, 1989, p. 106).
- Parent material, exerting the principal influence at the onset of pedogenesis, becomes relatively unimportant over vast periods of time and will, therefore, tend to be relatively unimportant for mature (near equilibrium) soils (Weaver, 1989, p. 106).
- Geomorphology and topography are constantly changing and exert, therefore, a constantly changing influence on pedogenesis (Brady, 1974, p. 309).[2]
- The biotic factor is strongly influenced by climate. Its influence, though sometimes slight, may result in a great cumulative effect over vast periods of time (Paton, Humphreys, and Mitchell, 1995, pp. 33–86).
- Ground water is a secondary variable largely determined by climate and topography (Jenny, 1941, p. 92).
- Epigenesis is largely determined by climate and topography (Weaver, 1989, pp. 107,143). With much time available, many soils can be assumed to be mature and specific clay minerals (physils) can be assumed to be products of epigenesis (Selley, 1976, p. 55).
- Much time favors translocation of physils and ions, resulting in formation of soil horizons, including argillic and cambic horizons (Blatt, Middleton, and Murray, 1972, p. 254).
- Highly leached soils, in both extent and magnitude, can be expected when vast amounts of time have been available for soil formation (Selley, 1976, p.55; Williams, 1969).
- While organic matter can rapidly reach equilibrium in soil, it can have a great effect on both leaching and the formation of horizons when great amounts of time are available (Selley, 1976, p.54).

DGP Expectations

- Climate has exerted its influence on pedogenesis over a relatively short period of postdiluvian time. Climate change has tended to be significant, possibly exponential, damped sinusoidal, or stochastic, and was likely warmer and wetter in early postdiluvian time than now (Oard, 1990).
- Parent material, exerting the principal influence at the onset of pedogenesis, is likely to be much more important than commonly perceived by EGP adherents, and may include stratification, oxidation, well developed weathering profiles, and initial physil content that can be falsely inferred as pedogenic.
- Geomorphology has probably changed little since the Deluge, and topography may also have remained constant in many places. Their effect, therefore, has been a relatively constant modifying influence on the climatic and other factors.
- The biotic factor is strongly influenced by climate. Organic matter could be expected on much of the ground surface or incorporated into sediments at the beginning of the postdiluvian period (Scheven, 1996). A warmer, wetter climate would have encouraged rapid growth of plants (Buol *et al*., 1990) and both microscopic (Brady, 1974, pp. 111–132) and macroscopic animals, expediting soil formation.
- Ground water could be expected to begin as a maximum, with saturated ground and a moist climate, approaching modern levels in response to climatic changes, topography and hydrogeologic (parent material) properties.
- Rates of epigenesis may have been greatly affected by significant climate change, atmospheric aerosols (Brady, 1974, p. 282; Oard, 1990), and carbon dioxide levels due to decaying organic matter (Paton, Humphreys, and Mitchell, 1995, p. 17).
- With relatively little time available, translocation of physils could be expected to be slight in some soils and a nonlinear (possibly exponentially decreasing) function with time.
- Highly leached soils, in both extent and magnitude, would only be expected to result from initially leached material (i.e. geological, not pedological, origin), accelerated weathering in an environment unlike the current environment, or more rapid actual rates of leaching than are commonly expected for the modern environment.
- Long periods of time for organic leaching and bioturbation would not be available. Thus, pedogenesis attributed to these processes by EGP adherents may be overstated, modern rates may be understated, or past rates may have been significantly higher during times of more favorable climate.

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[2] Geomorphology (large-scale landforms) and topography (local scale) are constantly being eroded, slope angles becoming reduced, etc. These changes occur over time. Geomorphology, as practiced, is often focused on reconstructing natural history and relies heavily on stratigraphy (Daniels, Gamble, and Cady, 1971, p. 55). Stratigraphy, as practiced, is generally unscientific (Klevberg, 1999, 2000a, 2000b; Woodmorappe, 1999a).

Natural History Inferences and the Five Environmental Factors

As summarized in Table I, expectations of the behavior of the climatic environmental factor ($\partial^2 S/\partial C\partial t$) differ markedly between the EGP and DGP. Based on a biblical view of earth history, climate would probably describe a roughly exponential curve from initial conditions at the end of the Deluge to current "equilibrium" conditions (recognizing normal climatic fluctuations). This can be expressed as $\partial C/\partial t \neq 0$ (i.e. climate change occurs) and $\partial^2 C/\partial t^2 \neq 0$ (i.e. climate change is nonlinear). Initial climatic conditions (C_0) would be determined by long-term (equilibrium) factors in the antediluvian and diluvian periods, and initial geomorphology (G_0) and initial ocean temperature at the end of the Deluge. Equilibrium climate would be dependent on atmospheric conditions (greenhouse gases, volcanic aerosols, variations in insolation) and changes in terrestrial conditions (land surface coverage by vegetation, water or ice.) The rate of change of climate would therefore have been a function of initial conditions (including G_0) and equilibrium (long-term) conditions (including B). The DGP envisions relatively warm, moist conditions in early postdiluvian time (Oard, 1990), circumstances favorable to relatively high rates of epigenesis, physical weathering, and leaching.

As summarized in Table II, expectations of the importance of parent material to soil formation ($\partial^2 S/\partial M\partial t$) and nature of the "initial" parent material (M_0) differ significantly between the EGP and DGP. According to the DGP, initial (t_0 = end of the Deluge) parent material (M_0) would plainly be a result of the Deluge. In addition to unweathered rock[3], one would expect weathered rock and unconsolidated sediments to have been common on the surface of the earth. It would, in fact, be expected that very little fresh bedrock would have been exposed by the final, waning currents of the Flood waters. Thus, M_0 may not be assumed to consist solely of homogeneous, unweathered rock. Graded sequences of unconsolidated sediments would be expected from waning flows of sediment laden currents. It may, therefore, be difficult in some cases to differentiate between horizons resulting from diluvial sedimentation processes and buried soil horizons or certain profiles which may have resulted from soil forming processes. Eluviation and illuviation would suggest soil forming processes (not unequivocally, cf. Birkeland, 1974, p.

Table I. Comparison of Parameters: Climatic Environmental Factor.

Parameter	EGP	DGP
C	Very important to soil formation; largely dependent on G and various independent variables	Very important to soil formation; largely dependent on C_0, G and various independent variables
C_0	On average, similar to current	May have been significantly warmer at end of Deluge
$\partial C/\partial t$	Gradual oscillations over long periods of time	Rapid change (exponential) following Deluge ($\partial C/\partial t \neq 0$)
$\partial^2 C/\partial t^2$	Value small or zero	Value may have been large following Deluge ($\partial^2 C/\partial t^2 \neq 0$), decreasing with time
$\partial^2 S/\partial C\partial t$	A generally linear (gradual) change (soil formation) over vast periods of time	A generally exponential decrease in change (rate of soil formation) since Deluge

Table II. Comparison of Parameters: Parent Material Environmental Factor.

Parameter	EGP	DGP
M	Very important to soil formation; a complex result of C, G and other variables	Very important to soil formation; primarily a result of M_0 modified by C, G, B, W and other variables
M_0	May be assumed as homogeneous and unweathered	May have been heterogeneous and contained weathered materials already at end of Deluge
$\partial M/\partial t$	Weathering occurs ($\partial M/\partial t \neq 0$) and is important process; it has proceeded over vast ages	Weathering occurs ($\partial M/\partial t \neq 0$) and is important process; it may occur or have occurred more rapidly than commonly believed
$\partial^2 M/\partial t^2$	Value of $\partial^2 M/\partial t^2$ small or zero	Value may have been large following Deluge ($\partial^2 M/\partial t^2 \neq 0$), decreasing with time
$\partial^2 S/\partial M\partial t$	A generally linear (gradual) change in soil state (i.e. soil formation) over vast periods of time	A generally exponential decrease in change (rate of soil formation) since Deluge (i.e. $\partial^2 S/\partial M\partial t^2 < 0$)

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[3] A small amount of this may have been antediluvian, in which case it would have been predominantly primordial based on the biblical historical record.

111), though these rates could also be expected to have been higher in the past. Fresh volcanic ash would have been abundant immediately after the Deluge and for some time thereafter (Oard, 1990;Whitcomb and Morris, 1961) and may have been important in the formation of some soils (including entisols and especially andisols[4]). Both the EGP and DGP understand that the parent material factor is not static. If a traditional soil forming factor definition is used ($\partial S/\partial M$), both the EGP and DGP recognize that $\partial M/\partial t \neq 0$, i.e. weathering occurs. Some disagreement may exist on the value of $\partial M/\partial t$, especially if estimates are based on natural history assumptions ("dating" methods). With our preferred definition of parent material as an environmental factor, the DGP certainly recognizes that $\Delta M \neq 0$, i.e. transport into and out of the control volume occurs (including clays), and adherents of the EGP are increasingly recognizing this also (Chadwick *et al*., 1994, p. 94; Daniels, Gamble, and Cady, 1971, pp. 51–88; Lavkulich, 1969, p. 28; Nettleton, Price, and Bowman, 1990, p. 152; Paton, Humphreys, and Mitchell, 1995; Simonson, 1959; Weaver, 1989 p. 182; Valentine and Dalrymple, 1976). In the DGP, we would expect $\partial^2 M/\partial t^2 \neq 0$, i.e. sediment transport rates would not have been constant.

As shown in Table III, there exists a mixture of agreement and disagreement between the EGP and DGP on the likely role of the geomorphic factor in soil formation during earth history. Substantial agreement exists on the small scale of local topography; substantial disagreement exists on the large scale of geomorphology. Unlike the EGP, which envisions vast changes in landscapes over vast periods of time ($\Delta G >> G_0$), the DGP envisions only minor changes to the landscape during the comparitively brief span of postdiluvial time. The abative and dispersive phases of the Deluge (Walker, 1994) would have been primarily responsible for the present landscape. Geomorphic modification by wind, ice and water since the end of the Deluge would have been minor ($\Delta G << G_0$). Most soils can thus be expected to have formed in pretty much the same geomorphic environment as at present on the large scale, though significant changes may have occurred on the small scale. Topographic changes have been primarily a function of climate (C) and parent material (M), since the presence of plants, an important consideration in slope stabilization, would largely depend on climate and parent material. As a result, $\partial^2 G/ \partial t^2 \neq 0$, i.e. rates of erosion, would have varied in the past, in agreement with the observation that the rate of lateral and vertical transport of earth materials is generally nonlinear. "Erosion rates are roughly proportional to slope; other conditions being equal, doubling the angle of slope increases the loss of sediment by about two and a half times. Doubling the length of slopes increases the loss about one and a half times" (Hunt, 1972, p. 51). Thus, other variables assumed constant, erosion rates can be expected to slow as slope angles decrease.

As summarized in Table IV, expectations of effects of the biotic factor over earth history differ between the EGP and DGP. In general, DGP expectations include much greater fluctuations in the magnitude of effects to soil formation in the past that envisioned by EGP adherents. At t_0, organic matter (O_0) can be expected to have been present in many locations as debris left by the Deluge (Genesis 8: 11, Holroyd, 1996; Oard, 1995a, 1995b; Sheven, 1996). The DGP envisions rapid colonization of the denuded earth by plants (Genesis 8:11). Successions would probably have occurred rapidly at first, especially with rapid climate change (i.e. $\partial B/\partial t \neq 0$), slowing in response to declining values of $\partial C/\partial t$ and $\partial M/\partial t$ (i.e. $\partial^2 B/\partial t^2 \neq 0$). Since fresh water is less dense than salt water, initial salt concentrations would not be expected to hinder plant growth in

Table III. Comparison of Parameters: Geomorphic Environmental Factor.

Parameter	EGP	DGP
G	Important to soil formation; primarily a function of C and M, secondarily B and W	Important to soil formation; primarily a function of C, M and G_0, secondarily B and W
G_0	May have been vastly different from present on both large and small scales	Geography at end of Deluge probably very similar to present
$\partial G/\partial t$	Great changes have occurred over vast periods of time ($\Delta G >> G_0$)	Large-scale geomorphology probably has changed very little in postdiluvian time ($\Delta G << G_0$ and $\partial G/\partial t$ is small), though significant local (small-scale) topographic changes may have occurred
$\partial^2 G/\partial t^2$	Value small or zero, especially as long-term average	Value decreasing following Deluge ($\partial^2 G/\partial t^2 < 0$), especially with revegetation
$\partial^2 S/\partial G \partial t$	A generally linear (gradual) change (soil formation) over vast periods of time	A generally static variable at large scale, episodic at small scale

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[4] Rapid formation of entisols (soils lacking distinct horizons) and andisols (derived from volcanic material) is often accepted in the EGP; however, volcanic ash may have been important in the formation of other soils (Froede, 1995, 1996; Ping, 2000, pp. 1262–1263; Selley, 1976, p. 57; Weaver, 1989, p. 154; Williams *et al*., 1998).

most surficial diluvial deposits. In addition, abundant moisture would have facilitated leaching of the salts from the soils at a more rapid rate than at present. Meteoric water would have served to dilute salts. Treating residual organic matter as a component of M_0, it is evident that B is primarily a function of C (modified by G) and M, with W dominating only in particular environments.

Table V summarizes the different natural history expectations of the EGP and DGP relative to soil forming effects of ground water. Ground water can affect pedogenesis much more strongly than has typically been acknowledged in the past (Twidale, 1990). Weathering may be much more rapid than would be anticipated from climate alone (Birkeland, 1984, p. 307). "If appreciable water is available, not necessarily rainfall, and can move freely (relief, porosity, permeability) virtually any rock or aluminosilicate mineral will alter to kaolin-gibbsite-Fe oxides suite" (Weaver, 1989, p. 143). The EGP envisions gradual change as typical of most environments, so little change in ground water hydrology would be expected. The DGP envisions W_0 as a maximum at the end of the Deluge. The rate at which present ground water conditions would be reached would be dependent upon the hydrogeology of the site (M) and climate, along with the influence of plants. Locally, topography would exert a strong influence in driving W toward its equilibrium condition. Insofar as soil formation was a function of ground water, the rate of soil formation could be expected to follow this (generally) declining curve.

Natural History Inferences and the Four Soil-Forming Mechanisms

The changes that occur within the soil (i.e. the control volume) can be categorized as epigenesis, physical weathering, leaching, and the accumulation and effects of organic matter. As used here, $\partial^2S/\partial E/\partial t$ refers to the time derivative of change in soil state due to effects of epigenesis, i.e. mineral transformations due to chemical

Table IV. Comparison of Parameters: Biotic Environmental Factor.

Parameter	EGP	DGP
B	Important to soil formation, but a secondary variable, i.e. B is highly dependent on C and M, also dependent on G, locally W	Important to soil formation, but a secondary variable, i.e. B is highly dependent on C and M, also dependent on G, locally W
B_0	On average, similar to present	May have been significant amounts of organic matter incorporated into O_0 at end of Deluge
$\partial B/\partial t$	No significant global trend with time, but local changes over long periods could be great due to climate change, etc.	Rapid change (exponential) following Deluge ($\partial B/\partial t \neq 0$), especially revegetation; microbial activity probably optimized at end of Deluge
$\partial^2B/\partial t^2$	Value small or zero	Value may have been large following Deluge ($\partial^2B/\partial t^2>0$), decreasing with time ($\partial^2B/\partial t^2<0$)
$\partial^2S/\partial B\partial t$	A generally linear (gradual) change in soil state (i.e. soil formation) over vast periods of time	Soil formation likely to be a complex, stochastic response to biologic mechanism due to number of variables

Table V. Comparison of Parameters: Ground Water Environmental Factor.

Parameter	EGP	DGP
W	Locally important to soil formation, but a secondary variable, i.e. W is highly dependent on C, M, and G, less so on B	Locally important to soil formation, but a secondary variable, i.e. W is highly dependent on C, M, and G, less so on B
W_0	May have been less or more than at present due to changes in C and G over vast periods of time.	Expected to be a maximum in most cases immediately following Deluge
$\partial W/\partial t$	Gradual changes expected locally over long periods due to changes in C and G	In most cases, expected to fall relatively rapidly (rate dependent on M) following Deluge ($\partial W/\partial t<0$), driven toward equilibrium by C and G with lesser influence by B
$\partial^2W/\partial t^2$	Value small or zero	Value may have been large following Deluge ($\partial^2W/\partial t^2<0$), decreasing with time ($\partial^2W/\partial t^2\approx 0$)
$\partial^2S/\partial W\partial t$	Changes in water table likely to have been minor or gradual for most soils	Many soils may have experienced higher water table or soil moisture in past

weathering, including leaching and the effects of organic compounds. Table VI summarizes the differences between the EGP and DGP views of the epigenetic soil forming mechanism.

The EGP has the luxury of permitting either rapid or slow formation of minerals through alteration of parent material, but the uniformitarian bias generally prevents this in practice. “Clay-mineral formation and transformation in the soil is a slow process” (Birkeland, 1974, p. 247), a process often believed to require hundreds of thousands of years (Birkeland, 1984, p. 221). There is little incentive within the EGP to consider the possibility of relatively rapid epigenetic pathways, though some within the EGP are now beginning to recognize the possibility of specific physils or groups of physils in parent material rather than as solely the products of mineral transformation (Weaver, 1989, pp. 154–182).

Although much effort has been exerted in determining epigenetic pathways in response to climate, many physils identified in North American soils appear to be inherited from parent material unrelated to subjacent regolith (Hunt, 1972, p. 272). Weaver (1989, p.188) shows that EGP predictions do not match physil suites. “Again, the parent material helps determine the kind of clay that forms through availability and kind of bases” (Birkeland, 1974, p. 142). Nettleton, Price, and Bowman (1990,p. 152) found that “The clays[in Redlands and Witt aridisols] appear to be inherited from the parent material, or have accumulated from subsequent dust, because the primary sand and silt grains, except for biotite, are only slightly weathered.” Physil aggregates may be deposited in high energy environments where clay deposition would not normally be expected (Weaver, 1989, p. 116). Physils considered indicative of climate, e.g. montmorillonite, can form from a variety of parent materials (Weaver, 1989, p. 155) and can be found in various epimorphic combinations (Paton, Humphreys, and Mitchell, 1995, pp. 24–27).

Inferred rates of epigenesis are often decidedly biased by EGP presuppositions and “absolute dates” (Chadwick *et al.*, 1994; Colman and Dethier, 1986; Dahms *et al.*, 1997; Hall and Shroba, 1993; Leighton and MacClintock, 1962; Locke, 1986; Mahaney and Halvorson, 1986; Nahon, 1986; Taylor and Blum, 1995). EGP assumptions have long resulted in disparate, inconclusive, or incorrect estimates for epigenetic rates (Foss and Segovia, 1990; Grandstaff, 1986; Hall and Martin, 1986; Neall and Paintin, 1986), a fact even EGP adherents have recognized in some cases (Lowe, 1986; Paton, Humphreys, and Mitchell, 1995; White, Benson, and Lee, 1986) and that Jenny documented (1941, pp. 35–44) with rapid soil formation on Kamenetz Fortress in Ukraine (12 inches in 230 years), volcanic soils, sand dunes, and the work of Miss Shreckenthall on moraines in the Alps in the late 1800’s. Epigenesis is particularly rapid in tropical entisols, and carbonates may form rapidly enough to clog drain pipes (Hunt, 1972, pp. 45,46). Negligible varnish has formed at archaeological sites in the American Southwest since pueblos dated A.D. 1, yet it has been observed to have formed in railroad cuts and tunnels. The apparent necessary condition is the presence of water (Hunt, 1972, pp. 158–160). Thus, rates of epigenesis may be easily underestimated and requisite time for soil formation overestimated.

Evidence of significant epigenesis (physil development) in even the harsh environment of Antarctica has been observed on moraines believed to be only 17,000 to 21,000 years old according to the EGP (Ugolini, 1986). Much faster rates could obviously be anticipated for more temperate climates, especially where humid conditions exist. Lowe (1986, pp. 268–270) noted that the 10,000 to 15,000 years generally believed necessary for the transformation of volcanic glass and feldspar to halloysite via allophane was in significant conflict with the stratigraphy of New Zealand tephras. “This implies that tephra composition and site weathering conditions frequently may have been underestimated in favor of the *assumed* tephra age-based weathering sequence” (p. 270; emphasis ours). Halloysite (the end product of this sequence) has been observed to form in 300 to 4,000 years in the humid tropics (Lowe, 1986, p. 270). Depth of burial can significantly affect the rate of epigenesis (Lowe, 1986, p. 279). “The types and rates of formation and transformation of clay minerals derived from tephra deposits of acid to intermediate composition are determined chiefly by macro- and micro-environmental factors together with the mineralogical and physicochemical composition of the parent deposits. *The length of time of weathering in clay mineral genesis is indirect and subordinate in its effect, in that weathering rates, and weathering products and their alteration, are largely*

Table VI. Comparison of Parameters: Epigenetic Soil Forming Mechanism.

Parameter	EGP	DGP
Epigenetic Mechanism	$\partial^2 S/\partial E \partial t$	Generally assumed to occur gradually in response to climatic factor May have occurred rapidly in response to varying climate and other environmental factors
Initial Epigenetic State	E_0	Often assumed to be zero (i.e. stable physils derived from parent material by epigenesis) May be significant amount of inherited physils

dictated by other controls" (Lowe, 1986, p. 281; emphasis ours). Supposed intermediate species (e.g. allophane, imogolite) may persist, and supposed end products (e.g. halloysite, gibbsite) may form directly from tephra. These minerals can co-exist and often do (Lowe, 1986, p. 284)

Lowe's assertions are substantiated by the work of King (1986), who found little correlation between expected epigenetic products and a stratigraphic sequence of ash deposits in Canada. Surprisingly rapid epigenesis has been observed in ash from the 1980 eruption of Mount St. Helens (White, Benton, and Yee, 1986), with a rapidly declining rate of epigenesis attributed to a change from the initial domination of hydrochloric, nitric, and sulfuric acids to domination by the much weaker carbonic acid. Chloride and sulfate were leached within three months of ash deposition (White, Benton, and Yee, 1986, p. 372). While many EGP pedologists will agree that andisols can form rapidly, many of these epigenetic pathways are similar to those inferred for other soil orders.

"The rate of chemical weathering of geologic materials depends on the chemistry of weathering fluids and on the nature of reactions at mineral surfaces" (Colman and Dethier, 1986, p. 5). Growth of new mineral phases as epigenesis progresses in mineral crystal defects may enlarge these conduits, accelerating weathering, or occlude these passages, depending on the secondary mineral species (Eggleton, 1986). Weathering rinds with depth may result from variations in the rate of weathering, not the amount of time since deposition, since weathering in the shallow subsurface is generally greater than either surficial weathering or weathering at depth (Twidale, 1990, p. 36). Weathering rinds are probably more indicative of soil moisture than age (Twidale, 1990, p. 30). Oxisol formation appears to be greatly affected by lateral soil moisture movement, resulting in segregation of aluminum, magnesium, and iron, and possibly the formation of stone lines (Birkeland, 1974, pp. 193, 194). Organic matter and compounds can greatly accelerate chemical weathering in the solum (Birkeland, 1984, p. 75; Brady, 1974, p. 310; Paton, Humphreys, and Mitchell, 1995, p. 17; Ruhe, 1975, p. 27). The DGP envisions conditions generally more conducive to epigenesis during the early postdiluvian period than at present.

As used here, $\partial^2 S/\partial P \partial t$ refers to the time derivative of change in soil state due to effects of physical weathering, including both breakdown of individual rock and mineral grains, and translocation of soil particles (i.e. particle movement within the control volume). Table VII summarizes the differences between the EGP and DGP views of the physical weathering soil forming mechanism.

Mechanical breakdown of rocks can occur as a result of physical and thermal stresses. Although temperature fluctuations in themselves are probably a negligible factor (Birkeland, 1974, p. 59), ice lenses that form in soil attract water and grow, often inducing significant stresses (Hunt, 1972, p. 94). Salts, clays, and plants can also induce significant physical stresses (Birkeland, 1974, p. 59). As mineral grains are broken down, resultant fine particles can be transported into the subsoil as suspended or dissolved load as leaching occurs.

Evidence of physical weathering can be equivocal. Grus development to great depth has been observed in arid climates, indicating chemical weathering rather than physical weathering, contrary to common belief (Birkeland, 1974, pp. 73–75). This may also indicate a wetter climate in these regions in the past. Patterned ground may be formed by processes other than freeze-thaw (Ruhe, 1975, pp. 208, 209). Stone lines may be formed pedogenically (Paton, Humphreys, and Mitchell, 1995, p. 84–86) or by creep, but often rounded or exotic clasts are present that neither process explains, thus indicating an unconformity (Ruhe, 1975, pp. 127-129). Tephra accumulation over a'a (a very rough-textured lava common in Hawaii, where Chadwick *et al*. conducted their study) produces horizons free of rock fragments overlying the a'a (Chadwick *et al*., 1994, p. 98), a profile that could be misinterpreted as evidence of physical weathering. "Because cumulative soils have parent material continuously added to their surfaces, their features are partly sedimentologic and partly pedogenic. In a soil study, therefore, it is important that sedimentologic features are not ascribed to pedogenesis" (Birkeland, 1984, p. 185).

Table VII. Comparison of Parameters: Physical Weathering Soil Forming Mechanism.

Parameter		EGP	DGP
Physical Weathering Mechanism	$\partial^2 S/\partial P \partial t$	Rates of mechanical breakdown of particles and translocation in solum typically slow—similar to modern rates–and often assumed to be linear	Rates of mechanical breakdown of particles and translocation may be relatively rapid, may have varied in the past and may be more exponential than linear in response to build-up of resulting substances
Initial Physical Weathering	P_0	Often assumed to be virtually zero	May have been substantial at end of the Deluge

Formation of an argillic horizon by translocation of clay-size particles is one of the most important processes in soil profile development for many soils. It is not possible to distinguish between clay translocated via suspension (P) or solution (L), and establishing that translocation of clay-size particles has occurred in a soil profile can be very difficult (Birkeland, 1974, p. 111). Argillic horizons are sometimes observed where they would not be expected, e.g. in aridisols. "Prominent argillic horizons occur only in soils [Redlands and Witt aridisols] that formed primarily during the Pleistocene and hence are largely relict," yet many factors would tend to rapidly destroy these features, not preserve them (Gile and Grossman, 1968, pp. 14, 15). This suggests that they may be relatively young. "Expression of the argillic horizon is related to soil age but not as closely as the horizon of carbonate accumulation" (Gile and Grossman, 1968, p. 15)[5]. Weaver (1989, p. 115) states, "The time factor [re: clay translocation] has been difficult to quantify." Data are needed on clay translocation rates and the effects of aeolian clay and silt on B horizon development in texture-contrast soils (Boardman, 1985, p. 72). Sesquioxide concentrations sometimes exceed what may be expected from parent material, indicating transport, but sesquioxides, carbonates, electrolytes, and positively charged coloids also inhibit clay migration, and above approximately 20 to 40 percent clay content (depending on physil species), clay translocation may virtually cease (Birkeland, 1974, pp. 111–114; Blatt, Middleton, and Murray, 1972, p. 254). Thus, modern rates may differ substantially from rates in the past, often being much lower. Based on archaeological evidence, clay translocation in alfisols can readily occur in fewer than three thousand years, and lateral ground water movement may be important in translocation (Fisher, 1983).

As used here, $\partial^2S/\partial L\partial t$ refers to the time derivative of change in soil state due to effects of leaching of ions from the solum by meteoric water. Table VIII summarizes the differences between the EGP and DGP views of the leaching soil forming mechanism.

Leaching is largely a function of climate, being dependent on the availability of excess moisture to provide free water for transport of ions from the solum (Locke, 1986). "The most active agency in soil-profile formation is percolating water" (Jenny, 1941, p. 47). White and Blum (1995) found that SiO_2 and Na weathering followed a linear function of precipitation and an Arrhenius temperature function (exponential). No climatic correlation was observed in leaching of K, Ca, or Mg. Grandstaff (1986) found an Arrhenius relation to temperature and proportionality to free ligand concentration for olivine weathering in Hawaiian beach sand. The importance of excess soil water has been established in modern environments. Chadwick *et al.* (1994, p. 102), in a Hawaiian study, noted, "Long term rates of desilication increase by nearly an order of magnitude as time-weighted median rainfall increases from 20 to 350 cm. Long term rates of base action leaching increase by about a factor of about 4 over the same rainfall gradient."

As pointed out by Chadwick *et al.* (1994 p. 94), "All regional and global estimates of chemical weathering are derived from dissolved load output from Earth's major river systems." Thus, common estimates for the rate of past soil formation are automatically uniformitarian, assuming current conditions as analogous to past conditions. Taylor and Blum (1995) derived silicate weathering rates by means of "known" ages, the result being 3.4 times faster than estimates based on stream flows. Yet present rates are considerably in excess of rates expected from the "known" ages of the moraines in their study, an observation that might be expected by diluvialists. Dahms *et al.* (1997) point out that Taylor and Blum erred to assume a closed system and that their reported precision in estimating weathering rates is impossible. Similar efforts based on "known ages" have been made by Hall and Martin (1986), Locke (1986), Mahaney and Halvorson (1986), and others. Since diluvialists would expect a higher temperature and precipitation regime immediately after the Deluge (Oard, 1990), significantly higher rates of leaching could be expected in many parts of the world, with the rates declining thereafter to modern values. Discrepancies between current rates of leaching and those anticipated based on EGP scenarios may be expected. "Texture influences the rate and depth of leaching, and this is related to many soil properties" (Birkeland, 1974, p. 142). Just translocation within the solum to form an argillic horizon ($\partial^2S/\partial P\partial t$) could be expected to reduce soil permeability by a couple orders of

Table VIII. Comparison of Parameters: Leaching Soil Forming Mechanisms.

Parameter		EGP	DGP
Leaching Mechanism	$\partial^2S/\partial L\partial t$	Rate largely determined by climate, often assumed similar to present	Rate largely determined by climate, which may have been somewhat warmer and much moister than present
Initial Leaching	L_0	Often assumed to be zero	May have been quite high at end of Deluge

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[5] Birkeland (1974, p. 170) notes that the modern $CaCO_3$ influx to aridisols similar to those studied by Gile and Grossman is too low to explain observed concentrations even with the ages ascribed to them by the EGP.

Table IX. Comparison of Parameters: Organic Matter Soil Forming Mechanisms.

Parameter		EGP	DGP
Organic Matter Mechanism	$\partial^2 S/\partial O \partial t$	Rate largely determined by climate, often assumed similar to present or slightly more favorable for histosol formation during or after ice ages	Rate largely determined by climate, which may have been somewhat warmer and much moister than present, possibly cooler at end of postdiluvial ice age
Initial Organic Matter	O_0	Often assumed to be zero in parent material	May have been considerable at end of Deluge

magnitude, suggesting that leaching of the A horizon may have been less and of the B horizon more in the past for many ultisols and alfisols. For example, a poorly graded (well sorted) sand may have a permeability of 10^{-2} cm/sec, but if silt or clay particles occupy many of the pore spaces between sand grains, the permeability may be reduced to 10^{-4} cm/sec. Formation of laminae in petrocalcic horizons may have been slow *or rapid*—data are insufficient (Daniels, Gamble, and Cady, 1971, p. 75, emphasis ours). The natural history scenario of the DGP predicts that many soils would have experienced rapid initial leaching of already weathered parent material, with the rate of leaching declining in response to drier climates and, in some cases, decreasing permeability of the solum.

As used here, $\partial^2 S/\partial O \partial t$ refers to the time derivative of change in soil state due to effects of organic matter present in the soil. Table IX summarizes the differences between the EGP and DGP views of the organic matter soil forming mechanism.

"Organic matter probably reaches a steady state more rapidly than any other property of the soil," states Birkeland (1984, p. 203), "Nevertheless, these and other data suggest that the time to achieve steady state may range from as little as 200 years to perhaps 10,000 years." Organic matter as an argument for long times of formation hinges primarily on quantity, especially the amount of time required to form the extensive peat bogs in some parts of the world. Organic matter has been used in attempts to date deposits using radiocarbon (^{14}C) dating. Effects of organic matter on soil formation are also important, since organic matter can strongly influence the rate of formation of mineral soils.

The question of organic matter accumulation and time of formation may be illustrated by returning to our Leteensuo Peat Bog example (Klevberg and Bandy, 2003, p. 256). Assuming no initial organic matter ($O_0 = 0$) and an exponential decline in peat accretion from the initial maximum rate of Retallack (1990, p. 271) of 20 cm/year to 0.5 mm/year within the space of four millennia of postdiluvial time results in the following equation:

$$h = 200\, e^{-0.001\,5t} \qquad (1)$$

where h is net annual peat accumulation in millimeters and t is time in years since the Deluge.

Total peat accretion, H, can therefore be calculated for any time period to the present:

$$H = \int 200\, e^{-0.001\,5t}\, dt \qquad (2)$$

This scenario results in total peat accretion of 133 m in 4,000 years! This is greatly in excess of commonly observed histosol thicknesses, and at an average rate of accumulation *much less* than Retallack's "maximum conceivable rate." Using Equation (2), the time required to form the Leteensuo Peat Bog would have been approximately 2,300 years with an *initial* (maximum) rate of 15.5 mm/year, roughly 8% of Retallack's "maximum conceivable rate." Even assuming a constant rate of formation of 2.5 mm/year and no initial organic matter, the Leteensuo Peat Bog could have formed in 4,000 years. According to the DGP, O_0 was very likely nonzero. The rapidity with which histosols, can form, even in modern environments, is illustrated by a 175 mm thick histic epipedon constituting part of a mucky soil 735 mm thick (a nascent histosol) formed northwest of Augusta, Montana, in eighty years (Figures 2 and 3) since the commencement of irrigation. This is a good, though not ideal, site for histosol formation.

It may be argued that histosol formation is dependent on a narrow range of conditions which change over time, principally the position of the water table relative to the ground surface, and that average rates of net annual peat accumulation of much less than 1 mm/year are possible (Hunt, 1972, p. 161). However, this assertion devolves to a simple statement of the need for a site-specific hydrogeologic study, which in some cases may indicate that the water table probably rose concurrently with addition of organic matter (we here include the organic material as a "geologic material" for the study of ground water hydrology—obvious hydrogeologist bias!). That many peat deposits include allochthonous organic matter (i.e. $O_0 > 0$) is indicated by the presence of calcite and dolomite nodules in some deposits incompatible with modern swamp environments (Retallack, 1990, p. 411).

Radiocarbon dating has been attempted in many studies of organic-rich soils, but it is difficult at best due to the mobility of carbon (Weaver, 1989, p. 106) and mixing with "old" carbon in the many soils containing carbonates (Ruhe, 1975, p. 226). Attempts to constrain weathering

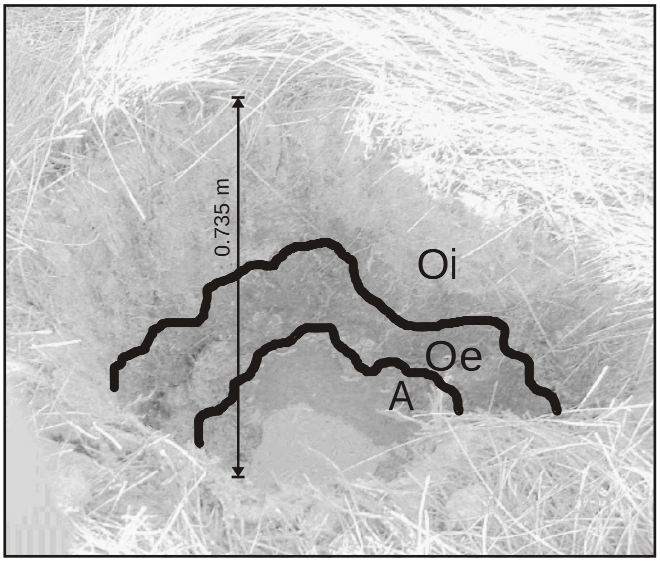

Figure 2. Test Pit in Wetland Near Augusta, Montana (nascent histosol).

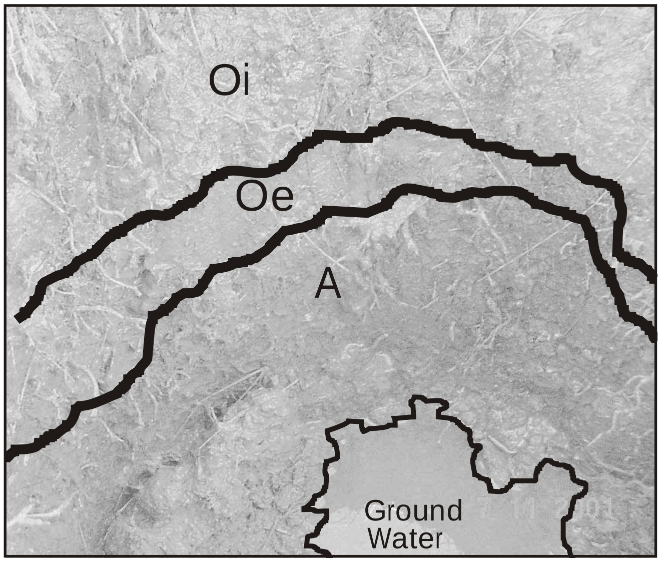

Figure 3. Recently Formed Histic Epipedon near Augusta, Montana.

rate estimates using radiocarbon dating can produce scattered data with no evident trend (Neall and Paintin, 1986). Fallacies inherent in the "dating" method itself have been documented elsewhere (Whitelaw, 1993; Woodmorappe, 1979; 1999b).

Some have argued that soils would have been sterile in early postdiluvian time (Harding, 2001), but this is most certainly not the case. Although some plants can tolerate soil lacking organic matter, humus development greatly increases the suitability of a soil to support plant life (Brady, 1974). Although much of the enormous antediluvian biomass no doubt ended up as coal, oil, natural gas, and carbononiferous and kerygenous matter (Woodmorappe, 1993), certainly some of this organic matter would have been incorporated into surficial sediments, often on top of them (Holroyd, 1996). At least in some locales, such organic material can be expected to have been abundant at the end of the Deluge. This would readily decay in the warm, humid conditions expected to prevail at that time, resulting in rapid formation of humus. Humus and other products of the decay of organic matter result in greatly accelerated epigenesis (Birkeland, 1984; Brady, 1974; Paton, Humphreys, and Mitchell, 1995).

Traditional Views in Light of Modern Data

Data obtained over a century of pedologic research have not substantiated the popular conceptions of the EGP. Instead, the complexity of pedogenesis has become more apparent, and attempts to infer times of formation for various soils based on "maturity" have been abandoned. More refined dating attempts have suffered from circular reasoning and the complex interdependence of assumptions undergirding so-called "independent" methods within the EGP (Klevberg, 2000b, p. 95; Thompson and Berglund, 1976). Since most questions in pedogenesis are historical, not scientific, conclusions must be based on historical records or natural history assumptions. In most cases, the assumed history of the DGP would enhance rates of soil-forming mechanisms, while many estimates based on EGP assumptions actually produce rates lower than those observed operating today. These differences are displayed in Table X.

Based solely on the assumed earth history of each geologic paradigm, very different expectations for rates of soil formation are generated. These are summarized below:

Climate: Climate change is now widely acknowledged (Birkeland, 1984; Hunt, 1972; Lavkulich, 1969.) Evidence for wetter climates in the past is common (Hunt, 1972, p. 158; Oard, 1990, p. 78).

Parent Material: Parent material has been recognized as responsible for some features formerly expected to be dominated by climate (Birkeland, 1984, pp. 177–189; Paton, Humphreys, and Mitchell, 1995), though what constitutes "parent material" remains a matter of debate. Diluvialists will recognize the likelihood of weathered, sometimes stratified, and often physil-rich parent material.

Geomorphology: Geomorphology and topography constitute a modifying factor. EGP advocates place a greater emphasis on geomorphic changes than do diluvialists.

Organisms: The ability of organisms to facilitate epigenesis has come to be recognized (Ruhe, 1975, p. 27), as has the significance of bioturbation (Paton, Humphreys, and Mitchell, 1995, pp. 33–78).

Ground Water: Ground water, in both the saturated and vadose zones, is now being recognized as far more important than many had previously believed (Twidale, 1990).

Table X. Comparison of Expected Rates of Soil Formation (DGP/EGP[1]).

Soil-Forming Mechanism[3]	Environmental Factors[2] C	M	G	B	W
E	+	+	NA	+	+
P	+	+	0	–	+
L	+	NA	0	+	+*
O	+	+*	NA	+/–	NA

[1] Qualitative comparison of DGP to EGP: + = soil formation due to indicated relationship more rapid in DGP scenario than EGP scenario; – = soil formation expected to be more extensive in EGP than DGP; 0 = degree of expected soil formation similar in DGP and EGP; NA = relationship between indicated factors not apparent or deemed minor.

[2] Environmental factors: C - climatic factor, M - parent material factor, G - geomorphic factor, B - biotic factor, W - ground water factor.

[3] Soil-forming mechanisms: E: epigenesis (mineral transformation), P: physical weathering, L: leaching, O: soil organic matter.

*Evaluation based on inferred initial conditions.

In general, the DGP envisions effects of environmental factors on pedogenesis resulting in significantly higher rates than the EGP, particularly in the past. These expectations are compatible with climatic and mineralogic data.

Epigenesis: Epigenetic pathways may be multiple and complex and represent thermodynamic systems (Lavkulich, 1969). EGP estimates based on "known" ages (including radiometric dates) are often lower than modern measured rates. Modern rates are often much less than rates expected by DGP adherents for past soil formation.

Physical Weathering: Some weathering processes thought to be physical may be chemical and more rapid than had been supposed. Observed relationships between clay particles and other soil substances indicates that translocation is a generally nonlinear and diminishing function with time. Translocation is known from archaeological evidence to occur within a few centuries or millennia.

Leaching: Many factors affect leaching rates. Measured rates of chemical weathering have exceeded rates expected based on EGP assumptions. Diluvialists not only expect past rates of leaching to have generally been higher than current values, but also expect initial parent material to have been weathered in many cases, making distinction between initial weathering profiles and subsequent leaching difficult in many soils.

Organic Matter: Rates of organic matter accumulation in modern environments can explain deep accumulations of peat within only a few thousand years, much less time than the EGP envisions since the last ice age. DGP adherents would expect some initial organic matter in many histosols, further reducing the time required for histosol formation. Radiocarbon "dating" is fraught with problems.

In general, the DGP envisions rates of soil-forming mechanisms declining from an initial maximum for many soils. These expectations are more compatible with observed rates than some EGP predictions, which are actually less than measured rates. Nonzero initial values, anticipated by the DGP, would further reduce the requisite time to reach the current state of soil development. *Some profiles probably could not have been preserved for the length of time envisioned by the EGP.*

Pedogenesis and the Question of Time

Much of the information presented above has been produced since we graduated from college. We shall now reevaluate arguments for long ages of soil formation that we formerly found quite convincing.

Oxisols

Oxisols are prominent for their lack of horizons and relative enrichment in aluminum and iron hydroxides. This can readily result from prolonged, intense leaching in a tropical climate, as is commonly asserted by EGP pedologists. Oxisols, particularly acrorthox, appear to provide strong evidence for an ancient earth. Many kaolinite and bauxite deposits are believed to be relict oxisols.

However, Boardman (1985, p. 71) points out problems in correlating soil redness with ambient temperatures. Estimates of acrorthox formation from both granitic and ultramafic rocks are less than 50 mm per thousand years (Nahon, 1986, p. 171). However, not only is this linear assumption suspect, but many of these soils are acknowledged to be relict (Nahon, 1986, pp. 184–186). Rates of formation are largely based on radiometric dating of associated volcanics (Nahon, 1986), an inference rife with faulty assumptions and readily discredited (Austin, 1992; 1994; 1996; Austin and Snelling, 1998; Woodmorappe, 1979; 1999a; 1999b). This is yet another example of the fact that *the past is the key to the present,* not vice versa.

Retallack (1990, p. 343) recognizes, "Alumina enrichment can be caused both by hydrothermal alteration and by weathering, so that care must be taken in interpreting aluminous rocks [bauxite] in highly deformed and very ancient terranes." Yet he (Retallack, 1990, p. 344) goes on to assert that kaolinite ". . . has persisted in these profiles despite subsequent diagenetic alteration, " an assertion clearly involving historic, nonscientific presuppositions. Selley (1976, p. 62) notes three sources of origin: 1) hydrothermal alteration of feldspars, 2) intense weathering of diverse rocks, and 3) transport and deposition.

Only 2) is a pedogenic process, and even it can be diagenetic rather than pedogenic, which may be indicated by the variability of residual kaolins (Selley, 1976, p. 62). That traditional explanations for oxisols fall short has been recognized for some time. “There are many unsolved problems concerning this soil type” (Blatt, Middelton, and Murray, 1972, p. 257).

Evidence *against* a pedologic origin of some alleged oxisols is very clear. Ganisters and tonsteins in Europe are probably intensely weathered volcanic ash beds rather than leached soil horizons (Selley, 1976, p. 76). Extensive bauxite deposits in Romania contain bones of dinosaurs and other fauna that are virtually impossible to explain pedogenically, and many deposits in North America run afoul of paleoclimatologic inferences (Oard, 1999). Some oxisols may be almost entirely geologic in origin, and others may be polygenetic. It is impossible to establish that any particular oxisol developed solely as the result of *in situ* weathering, but it is possible to demonstrate that at least some of these deposits did not. That many seem oblivious to geologic explanations for these deposits may stem from the pervasive tendency toward analytic specialization; pedologists will see pedologic explanations, sometimes where they do not exist.

Ultisols

Ultisols are typified by a deeply leached weathering profile and translocation of clays. Both the EGP and DGP recognize that ultisol formation is a nonlinear function with time (Birkeland, 1984, p. 225), but the natural history scenario envisioned by the DGP would result in a much less linear function. Diluvialists would expect rates of both leaching and translocation to have declined over time in response to soil profile development, as well as possible climate change. Present rates of these soil-forming mechanisms may, therefore, represent *minima* and not average values. To some degree, the response of leaching and translocation rates to soil profile development in ultisols can be evaluated by comparing them with alfisols, where formation within centuries or a few millennia has been observed. This not only suggests that formation of ultisols within a few thousand years is reasonable, but that the nonlinearity of leaching and translocation may call into question the possibility of traditional ages for many ultisols based on their current profile development. The importance of parent material in ultisol development may also have been underappreciated. “Although the native fertility disadvantage of the Ultisols may be attributed in part to the higher rainfall and temperatures [assumed in their global warming scenario], this is not a totally valid relationship; parent material is undoubtedly a very significant soil forming factor contributing to differences in native fertility between Mollisols and Ultisols” (Buol *et al*., 1990, p. 79). In the case considered by Buol *et al*., soil fertility and soil profile development are closely related.

Histosols

Histosols no longer appear a convincing argument for long periods of formation. The rapid formation of histic epipedons in recent times appears to indicate that *observed histosols permit too little time for the EGP*, suggesting that continental glaciation (generally believed to have occurred where the majority of histosols are found today) may have occurred more recently than can be accommodated within the EGP.

Alfisols

Alfisols, which exhibit less intensive leaching than ultisols, may be presumed to develop more rapidly than ultisols; however, differences in the climatic and parent material factors experienced by these soils may be more important than time in explaining these differences. Consider the Thoeny and Creed soils of northern Montana (U.S.D.A., 1986). The Thoeny series formed in “glacial till,” a diamict with a fine-grained matrix, in the time since the withdrawal of ice sheets from the area. The Creed series has formed in the same region and has thus experienced the same climatic influences, but it has formed in alluvium south of the ice limit. A typical pedon for both soils consists of A and E horizons to 6 inches (150 mm) with the base of the Bt horizon at 17 inches (430 mm) in the Thoeny and 16 inches (410 mm) in the Creed. According to the EGP, the Creed would be a much older soil and should be more highly developed, with a much deeper Bk horizon. It is apparent that the climatic influences have dramatically effected soil formation without being dramatically affected by time. It may be, too, that considerably less time has been available for pedogenesis than the EGP purports, with pedogenesis occurring relatively rapidly. Caution must be exercised in inferring times of development for alfisols. The ages assigned to the surfaces on which alfisols and ultisols are commonly found may relate to inferences based on the EGP. Investigation of the methods employed to “date” these surfaces is a worthy topic for further research but is beyond the scope of this paper.

Mollisols

Mollisols, though expected by diluvialists to form more rapidly than the EGP predicts, are not a matter of great controversy between the two paradigms. However, mollisols provide good examples of “average” soils that call into question the idea of slow pedogenesis. Consider the

Telstad (U.S.D.A., 1986) and Evanston soils of northern Montana (U.S.D.A., 1988, and unpublished data). Both are classified as fine-loamy, mixed, superactive, frigid, aridic argiustolls. The Telstad soil is formed in "glacial till," a diamict with a clay loam matrix, north of the Missouri River. The Evanston soil is formed in alluvium south of the Missouri River. (The Evanston series also occurs in alluvium which appears to be reworked till in various places north of the Missouri River; in these places, the Evanston is apparently *younger* than the Telstad, while south of the river it should be *older.) Both soils exhibit a mollic epipedon 4 to 6 inches (100 to 150 mm) deep over an argillic horizon. The uniformity and degree of profile development of mollisols on both terrain north of the Missouri River believed to have been glaciated and terrain south of the river believed to have escaped glaciation is similar. This could result from a great span of time since glaciation or from rapid soil profile development, but based on the Telstad and Evanston soils (as well as the Thoeny and Creed soils mentioned above), we favor the latter.*

Evaluating rates of pedogenesis

Complexities and limitations in evaluating rates of pedogenesis are many. "As more pedological research is carried out and more soils are observed and studied, the pedologist is recognizing that many of the soils occurring on the present landscape are polygenetic soils which have formed in part under environments different from those of the present" (Lavkulich, 1969, p. 26). Age estimates of soils based on assumptions of linear weathering or leaching rates are grossly simplistic (Ruhe, 1975, p. 202). Vreeken (1984) reviews methods of dating soils by dating surfaces, average pedogenic index, variable pedogenic index, paleopedogenic index, and soil-landscape analysis. He exposes the assumptions and circular reasoning that render these methods untenable. "Evidence has been presented that pedogenic processes have either been discontinuous through time, or there has been considerable variation in intensity of process. This work shows that soils scientists should be cautious about conjectures regarding soil genesis based largely upon soil-profile characteristics" (Daniels, Gamble, and Cady, 1971, p. 76). Because soil formation is so complex and site specific, obtaining a quantitative mathematical description of pedogenesis is virtually impossible. "In order to compare soil data on even a semiquantitative basis, a time scale must be adopted" (Birkeland, 1974, p. 153). Thus, *the view of natural history one adopts determines his bias in evaluating soil data.* We believe that even the cursory presentation of findings presented in this paper is sufficient to demonstrate that, in general, the diluvial approach to pedogenesis is more compatible with the data than the traditional, EGP view.

The Apparent Problem of Paleosols

While many soils may have formed much more rapidly than commonly thought, what of paleosols? Even soils formed in centuries or millennia must indicate the passage of great periods of time if sufficient numbers are superposed. While this is significant to neither creationism nor catastrophism *per se,* it does call into question the biblical historical record and the DGP. It has caused heartburn for some creationists (Robinson, 1996). Leighton and MacClintock (1962) state, "Recognizing the proper distinctions between a profile of weathering and a soil profile is of the greatest importance to both geologists and pedologists." Yet it is seldom possible to distinguish between a weathering profile and a soil profile (Ruhe, 1975, p. 36), and even argillic horizons and clay films have been observed to form sedimentologically (Valentine and Dalrymple, 1976, pp. 210, 211). Identification of ancient B_k horizons (caliche) is difficult at best. "Correct recognition of ancient caliche is an art and, as with most art, the experts often disagree among themselves concerning the criteria to be used in an evaluation" (Blatt, Middleton, and Murray, 1972, p. 259). "It is the similarity of the processes and products of pedogenesis to those of diagenesis that is one of the major causes of confusion in the recognition of buried paleosols" (Valentine and Dalrymple, 1976, pp. 210). Various laboratory techniques, including mineral and ion ratios, although often useful, are rife with pitfalls and often equivocal in their results (Brady, 1974, p. 312; Valentine and Dalrymple, 1976, pp. 211–213). Alternative explanations abound for features some think diagnostic of paleosols, and the alternative explanations are often more likely (White, 1998). Paleosols would not be likely according to the DGP view of earth history. Nonetheless, based on the relative rapidity of soil formation predicted by the DGP and observed in many modern environments, actual paleosols are not inimical to the DGP, a fact observed by some diluvialists (Froede, 1998, p. 27). Ultimately, since paleosols are historic by definition, they are not essentially scientific, though science is useful in testing EGP predictions to potentially disprove the interpretation of a given weathering profile as a paleosol.

Conclusions

Soil formation is ultimately an historic question with scientific implications. One's view of earth history establishes his bias in evaluating the pedologic data. Arguments for long times of formation hinge on faulty or questionable assumptions that include the following:

- Parent material is often assumed to be unweathered, unstratified, and barren of "mature" physils or organic matter.
- Rates of soil-forming mechanisms are often assumed to be nearly linear and approximately the same as modern rates, even though evidence of significant past climate change is mounting and soil profile development would affect the rates of soil-forming mechanisms.
- Radiometric "dating," "dating" of geomorphic surfaces, and other methods that *assume* the EGP are used to estimate soil formation rates.
- Physical weathering over long periods is sometimes invoked where chemical weathering may actually have caused a particular feature relatively rapidly.
- Pedologic explanations are sometimes sought where geologic explanations are more likely or even virtually certain (e.g. bauxite bone beds).

Current knowledge of pedogenesis permits the following assertions about "problem" soils:

- Oxisols may form more rapidly than commonly believed. They probably reflect parent material much more strongly and climate much less than traditionally thought. Evidence for formation of oxisols entirely pedologically is inherently equivocal, while evidence for a geologic, rather than pedologic, origin of at least some deposits classified as oxisols is well demonstrated. Many oxisols may be polygenetic.
- Ultisols and alfisols may have formed much more quickly than commonly believed if climates were generally warmer and wetter in the past and if one recognizes the probable nonlinearity of soil-forming mechanism rates.
- Histosol and mollisol formation is readily accommodated within the DGP, even using the rates of organic matter accumulation assumed by EGP adherents. The formation of these profiles may, in fact, be too quick for the EGP for some soils.
- Many "paleosols" are more readily explained as results of sedimentation or diagenetic processes. Being historic inferences, paleosols are interpretations of scientific data and not scientific "facts." Each must be evaluated by comparing predictions of the EGP paleosol scenario with scientific observations.

The natural history scenario of the DGP (based on the biblical record) generally predicts more rapid soil formation than does the EGP, and accumulated data are more readily explained by the DGP than by the EGP. Even oxisols and ultisols can form within the 4,000 to 5,000 years (Genesis 11, Exodus 12:40, Judges 11:26, I & II Chronicles, Matthew 1:1–17) since the Deluge. Careful distinction between scientific data and pedogenic inferences indicates that the biblical record of earth history is not contradicted by the pedologic data and in many cases is superior to the traditional view in interpreting observed soil characteristics and rates of pedogenesis.

Acknowledgments

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Glossary

allochthonous: said of sediments or materials whose place of origin appears to be different from present location, implying transport.
antediluvian: pertaining to the period of earth history between creation and the Deluge.
Deluge: the unique global Flood cataclysm (*mabbul* in Hebrew) that occurred during Noah's lifetime as described in the Bible.
diamict: a heterogenous, unconsolidated, unsorted sediment, typically consisting of coarse material such as gravel in a fine-grained matrix.
postdiluvian: pertaining to the period of earth history from the end of the Deluge to the present.

References

CRSQ: Creation Research Society Quarterly
CENTJ: Creation Ex Nihilo Technical Journal

Austin, Steven A. 1992. Excessively old "ages" for Grand Canyon lava flows. *Acts and Facts* 21(2):i–iv (Institute for Creation Research Impact Article No. 224).

———. 1994. Grand Canyon: monument to catastrophe. Institute for Creation Research, Santee, CA.

———. 1996. Excess argon within mineral concentrates from the new dacite lava dome at Mount St. Helens volcano. *CENTJ* 10:335–343.

Austin, Steven A., and Andrew A. Snelling, 1998. Discordant potassium-argon model and isochron "ages" for Cardenas Basalt (middle Proterozoic) and associated diabase of eastern Grand Canyon, Arizona. In Walsh, Robert E., editor, *Proceedings of the Fourth International Conference on Creationism*, pp. 35–51. Creation Science Fellowship, Pittsburgh, PA.

Birkeland, Peter W. 1974. *Pedology, weathering, and geomorphological research.* Oxford University Press, New York.

———. 1984. *Soils and geomorphology.* Oxford University Press, New York.

Blatt, Harvey, Gerard Middleton and Raymond Murray. 1972. *Origin of sedimentary rocks*. Prentice-Hall, Englewood Cliffs, NJ.

Boardman, John. 1985. Comparison of soils in Midwestern United States and Western Europe with the interglacial record. *Quaternary Research* 23:62–75.

Brady, Nyle C. 1974. *The nature and properties of soils (eighth edition)*. MacMillan Publishing Company, New York.

Brady, Nyle C., and Ray R. Weil. 1999. *The nature and properties of soils (twelfth edition).* Prentice-Hall Publishing Company, Upper Saddle River, NJ.

Buol, S.W., P.A. Sanchez, S.B. Weed, and J.M. Kimble. 1990. Predicted impact of climatic warming on soil properties and use. In *Impact of carbon dioxide, trace gases, and climate change on global agriculture*, pp. 71–82. American Society of Agronomy Special Publication No. 53.

Chadwick, O.A., C.G. Olson, D.M. Hendricks, E.F. Kelly, and R.T. Gavenda. 1994. Quantifying climatic effects on mineral weathering and neoformation in Hawaii. In *Transactions: 15th World Congress of Soil Science*, pp. 8a:94–105. International Society of Soil Science, Acapulco, Mexico.

Colman, Steven M., and David P. Dethier, editors. 1986. *Rates of chemical weathering of rocks and minerals*. Academic Press, San Diego.

Dahms, D.E., R.R. Shroba, J.C. Gosse, R.D. Hall, C.J. Sorenson, and M.C. Reheis. 1997. Relation between soil age and silicate weathering rates determined from the chemical evolution of a glacial chronosequence: comment and reply. *Geology* 25:381–382.

Eggleton, Richard A. 1986. The relation between crystal structure and silicate weathering rates. In Colman, Steven M., and David P. Dethier, editors. *Rates of chemical weathering of rocks and minerals,* pp. 21–40. Academic Press, San Diego.

Fisher, P.F. 1983. Pedogenesis within the archaeological landscape at South Lodge Camp, Wiltshire, England. *Geoderma*. 29:93–105.

Foss, John E. and Antonio V. Segovia. 1990. Rates of soil formation. In LaFleur, R.G., editor. 1990. *Groundwater as a geomorphic agent*. Allen & Unwin, Boston.

Froede, Carl R., Jr. 1995. A post-Flood (early ice age?) paleoenvironment in Mississippi. *CRSQ* 31:182–186.

———. 1996. A theory for the volcanic origin of radioactive shales and clays: examples from the southeastern United States. *CRSQ* 33:160–168.

———.1998. *Field studies in catastrophic geology*. Creation Research Society Books, St. Joseph, MO.

Grandstaff, D.E. 1986. The dissolution rate of forsteritic olivine from Hawaiian beach sand. In Colman, Steven M., and David P. Dethier, editors. *Rates of chemical weathering of rocks and minerals*, pp. 41–59. Academic Press, San Diego.

Hall, Robert D., and Robert E. Martin. 1986. The etching of hornblende grains in the matrix of alpine tills and periglacial deposits. In Colman, Steven M., and David P. Dethier, editors. *Rates of chemical weathering of rocks and minerals,* pp. 101–128. Academic Press, San Diego.

Hall, Robert D., and Ralph R. Shroba. 1993. Soils developed in the glacial deposits of the type areas of the Pinedale and Bull Lake glaciations, Wind River Range, Wyoming. *Arctic and Alpine Research* 25:368–373.

Harding, Ken. 2001. What would we expect to find if the world had flooded? http://www.geocities.com:0080/Tokyo/Temple/9917/flood.html

Holroyd, Edmond W., III. 1996. Confirmation from debris flow at a forest fire site. *CRSQ* 33:141–151.

Howe, George F. 1971. Seed germination, sea water, and plant survival in the great Flood. In Lammerts, Walter E., editor, *Scientific studies in special creation,* pp. 285–298. Baker Book House, Grand Rapids, MI.

Jenny, Hans. 1941. *Factors of soil formation: a system of quantitative pedology*. McGraw-Hill Book Company, New York.

Klevberg, Peter. 1999. The philosophy of sequence stratigraphy–Part I: philosophic background. *CRSQ* 36:72–80

———. 2000a. The philosophy of sequence stratigraphy–Part II: application to stratigraphy. *CRSQ* 37:36–46.

———. 2000b. The philosophy of sequence stratigraphy–Part III: application to sequence stratigraphy. *CRSQ* 37: 94–104.

Klevberg, Peter, and Richard Bandy. 2003. Postdiluvial soil formation and the question of time: Part I—Soil formation. *CRSQ* 39:252–268.

King, Roger H. 1986. Weathering of holocene airfall tephras in the southern Canadian Rockies. In Colman, Steven M.., and David P. Dethier, editors. *Rates of chemical weathering of rocks and minerals*, pp. 239–264. Academic Press, San Diego.

LaFleur, R.G., editor. 1990. *Groundwater as a geomorphic agent*. Allen & Unwin, Boston.

Lammerts, Walter E., ed. 1971. *Scientific studies in special creation*. Baker Book House, Grand Rapids, MI.

Lavkulich, L.M. 1969. Soil dynamics in the interpretation of paleosols. In S. Pawluk, editor, *Pedology and Quaternary research*, pp. 25–37. University of Alberta, Edmonton.

Leighton, Morris M., and Paul MacClintock. 1962. The weathered mantle of glacial tills beneath original surfaces in north-central United States. *Journal of Geology* 70:267–293.

Locke, William W. 1986. Rates of hornblende etching in soils on glacial deposits, Baffin Island, Canada. In Colman, Steven M., and David P. Dethier, editors. *Rates of* *chemical weathering of rocks and minerals*, pp. 129–145. Academic Press, San Diego.

Lowe, David J. 1986. Controls on the rates of weathering and clay mineral genesis in airfall tephras: a review and New Zealand case study. In Colman, Steven M., and David P. Dethier, editors. *Rates of chemical weathering of rocks and minerals*, pp. 265–330. Academic Press, San Diego.

Mahaney, W.C. (editor). 1984. *Quaternary dating methods*. Elsevier, New York.

Mahaney, W.C., and D.L. Halvorson. 1986. Rates of mineral weathering in the Wind River Mountains, Western Wyoming. In Colman, Steven M., and David P. Dethier, editors. *Rates of chemical weathering of rocks and minerals*, pp. 147–167. Academic Press, San Diego.

Neall, V.E., and I.K. Paintin. 1986. Rates of weathering of ^{14}C-dated late quaternary volcaniclastic deposits in the western United States. In Colman, Steven M., and David P. Dethier, editors. *Rates of chemical weathering of rocks and minerals*, pp. 331–350. Academic Press, San Diego.

Nahon, Daniel B. 1986. Evolution of iron crusts in tropical landscapes. In Colman, Steven M., and David P. Dethier, editors. *Rates of chemical weathering of rocks and minerals*, pp. 169–191. Academic Press, San Diego.

Oard, Michael J. 1990. *An ice age caused by the Genesis Flood*. Institute for Creation Research, San Diego.

———. 1995a. Mid and high latitude flora deposited in the Genesis Flood–Part I: uniformitarian paradox. *CRSQ* 32:107–115.

———. 1995b. Mid and high latitude flora deposited in the Genesis Flood–Part II: a creationist hypothesis. *CRSQ* 32:138–141.

———. 1996. The absolute dating of desert varnish likely inaccurate. *CENTJ* 10:178–179.

———. 1999. What can 10,000 dinosaur bones in a bauxite lens tell us? *CENTJ* 13:8, 9.

Paton, R.R., G.S. Humphreys and P.B. Mitchell. 1995. *Soils: a new global view*. Yale University Press, New Haven, CT.

Ping, Chien-Lu. 2000. Volcanic soils. In Sigurdsson, Haraldur (editor). 2000. *Encyclopedia of volcanoes*, pp. 1259–1270. Academic Press, San Diego.

Retallack, Gregory J. 1990. *Soils of the past: an introduction to paleopedology*. Unwin Hyman, Boston.

Robinson, Steven J.,1996. Can Flood geology explain the fossil record? *CENTJ* 10:32–69.

Ruhe, Robert V. 1975. *Geomorphology*. Houghton Mifflin Company, Boston.

Scheven, Joachim.1996. The Carboniferous floating forest–an extinct pre-Flood ecosystem. *CENTJ* 10:70–81.

Selley, R.C. 1976. *An introduction to sedimentology*. Academic Press, New York.

Sigurdsson, Haraldur (editor). 2000. *Encyclopedia of volcanoes*. Academic Press, San Diego.

Simonson, R.W. 1959. Outline of generalized theory of soil genesis. *Soil science of America proceedings.* 23: 152–156.

Taylor, Aaron, and Joel D. Blum. 1995. Relation between soil age and silicate weathering rates determined from the chemical evolution of a glacial chronosequence. *Geology* 23:979–982

Thompson, R. and B. Berglund. 1976. Late Weichselian geomagnetic ‘reversal’ as a possible example of the reinforcement syndrome. *Nature* 263:490–491.

Twidale, C.R.1990. Weathering, soil development, and landforms. In LaFleur, R.G., editor. 1990. *Groundwater as a geomorphic agent*, pp. 29–50. Allen & Unwin, Boston.

Ugolini, F.C.1986. Processes and rates of weathering in cold and polar desert environments. In Colman, Steven M., and David P. Dethier, editors. *Rates of chemical weathering of rocks and minerals*, pp. 193–235. Academic Press, San Diego.

U.S.D.A. 1986. *Soil survey of Blaine County and parts of Phillips County, Montana*. Soil Conservation Service [now Natural Resources Conservation Service], Washington, D.C.

U.S.D.A. 1988. *Soil survey of Fergus County, Montana*. Soil Conservation Service [now Natural Resources Conservation Service], Washington, D.C.

Valentine, K.W.G., and J.B. Dalrymple.1976. Quaternary buried paleosols: a critical review. *Quaternary Research* 6:2:209–222.

Vreeken, W.J. 1984. Relative dating of soils and paleosols. In Mahaney, W.C., editor. *Quaternary dating methods*, pp. 269–281. Elsevier, New York.

Walker, Tasman B. 1994. A Biblical geologic model. In Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism* (Technical Symposium Sessions), pp. 581–592. Creation Science Fellowship, Pittsburgh.

Weaver, Charles E. 1989. *Clays, muds, and shales*. Elsevier, New York.

White, Art F., Larry V. Benson, and Andy Yee. 1986. Chemical weathering of the May 18, 1980, Mount St. Helens ash fall and the effect on the Iron Creek watershed, Washington. In Colman, Steven M., and David P. Dethier, editors. *Rates of chemical weathering of rocks and minerals*, pp. 351–375. Academic Press, San Diego.

White, Art F., and Alex E. Blum. 1995. Effects of climate on chemical weathering in watersheds. *Geochimica et Cosmochimica Acta* 59:1729–1747.

White, E.M. 1998. South Dakota badlands paleosols: fact and fiction. *Soil Survey Horizons*, summer issue: 50–58.

Whitcomb, John C. and Henry M. Morris. 1961. *The Genesis Flood*. The Presbyterian and Reformed Publishing Company, Philadelphia.

Whitelaw, Robert L. 1993. Radiocarbon dating after forty years: do creationists see it as supporting the biblical creation and Flood? *CRSQ* 29:170–183.

Williams, Emmett L., Robert L. Goette, William G. Stark and George T. Matzko. 1998. Fossil wood from Big Bend National Park, Texas (Dawson Creek Region), Part V—Origin and diagenesis of clays. *CRSQ* 35:31–38.

Williams, George E. 1969. Characteristics and origin of a pre-Cambrian pediment. *Journal of Geology* 77:183–207.

Woodmorappe, John.1979. Radiometric geochronology re-appraised. In Woodmorappe, 1999: *Studies in Flood geology*, pp. 145–175. Institute for Creation Research, San Diego.

———. 1993. The antediluvian biosphere and its capability of supplying the entire fossil record. In Woodmorappe, 1999: *Studies in Flood geology*, pp. 13–20. Institute for Creation Research, San Diego.

———. 1999a. *Studies in Flood geology*. Institute for Creation Research, San Diego.

———. 1999b. *The mythology of modern dating methods*. Institute for Creation Research, San Diego.

Book Review

The Extravagant Universe by Robert P. Kirshner

Princeton University Press, Princeton, NJ. 2002, 282 pages, $29.95

Robert Kirshner received his Ph.D. in astronomy from the California Institute of Technology, Pasadena in 1974. He is Clowes Professor of Science at Harvard University and Head of the Optical and Infrared Division at the Harvard-Smithsonian Center for Astrophysics. He also is the leader of the "high-z supernova search team" (p.190), one of two international teams searching for high redshift supernova Ia to show acceleration and deceleration of the expansion of the universe. This book chronicles this quest from the discovery of galactic supernova in 1572 by Tycho Brahe thru the discovery of the high redshift supernova SN1997ff. This supernova leads theorists to an accelerating universe which points to the need for the Einstein cosmological constant, dark energy, and dark matter.

The book subtitle is "Exploding Stars, Dark Energy and the Accelerating Cosmos." Kirshner explains the latest knowledge of how the universe is viewed by most astronomers and how it supposedly evolved. He does it in language understandable to laymen and humor keeps the topics interesting. The book is well organized with eleven chapters, notes, references, and an index. The chapters include introductory material, proposed theories, data gathering procedures, application of the data, and future projects where supernova measurement methods may lead.

In general the book presents a strong case for the standard Big Bang theory including inflation and stellar evolution. However, it also documents a weakness in this theory, namely the lack of enough time since the Big Bang for supernova type Ia to evolve. Kirshner states "Type Ia supernova are responsible for making the iron in the earth's core, in the Eiffel Tower, and in your own blood" (p. 30). He also gives recent measurements of the Hubble constant which date the universe at less than 14 billion years old and the oldest stars in globular clusters at approximately 12 billion years old (p.111). He estimates the age of the sun and earth at 5 billion years (p. 23) as is required for life to have evolved. This leaves only 7 billion years for a sun-size star to form, burn its fuel, evolve into a red giant, blow off its atmosphere, and collapse its core into a white dwarf. The estimate he gives for the lifetime of our sun as a main sequence star is 10 billion years, then a lifetime of at least 1 billion years as a red giant (p. 26). If it is in a binary system it either has to collect 40 percent more mass from its partner or mutually lose enough orbital momentum to collide with its partner to become a supernova Ia. No time estimate is given for these processes but none can be considered fast. The same lack of time is demonstrated by the observation of a supernova 11 billion light years from earth (SN1997ff). How could this supernova have evolved in less than 3 billion years after the Big Bang?

It is evident from observational data presented in this book that God created a large variety of stellar phenomena at the beginning of time including supernova. Most scientists simply have the wrong idea about how and when. The observational data shows a universe that is fairly homogeneous in that galaxies 11 billion light years away do not look significantly different than nearby galaxies. It is mankind's misinterpretation of the data and their flawed theories which lead them away from God's truth about the creation of this universe and life.

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Forum on Dinosaur Eggs, Nests, and Tracks

Forum participants may question each other and readers are invited to submit letters of comment.

Dinosaur Eggs, Nests and Tracks: Evidence for or against the Noachian Deluge?

Edward C. Lain and Robert E. Gentet*

Empirical evidences of fossil dinosaur eggs, nest sites and billions of tracks are compelling evidence for geologic events other than the Noachian Deluge. These physical records, however, in no way contradict nor discredit the Genesis account of the Noachian Flood. Rather, the scriptural account mandates a creation/geologic model that allows for time indicators both pre- and post-Flood.

The Fossil Evidence

Dinosaur eggs were first discovered in southern France in 1859. Since then at least 170 different localities, particularly in Argentina, China, India and Mongolia, have yielded abundant egg fossils. For example: "With an estimated 2,000,000 eggs in 1000 km^2, the Xixia Basin, in Henan Province, China, is one of the premier sites for dinosaur eggs in the world" (Zhenya, 2003).

In addition, embedded within the geologic record, nesting sites have often been found associated with the eggs in many locations worldwide. It is not the purpose of this paper to summarize the volumes of material that has been written on dinosaur eggs and nests or their distribution (see Carpenter, et al, 1994; Carpenter, 1999). At some of the nesting sites there is fossil evidence that some of dinosaur eggs hatched and sufficient time passed for the young to reach a length of around three and a half feet (Horner, 1988, p. 113).

Further complications to placing these remains into the Flood event are found at some locations where there are nest sites at more than one stratigraphic level. Horner made a significant discovery:

> …in the area of the Willow Creek, Anticline, Teton Country, Montana. There is one lower horizon and two upper horizons. In the lower horizon, eight nesting sites were found, two of which contained babies (Horner, 1979). The two upper nesting horizons have also yielded skeletal remains. On all three horizons there are desiccation cracks, indicating that the surface was exposed for some time before being covered with sediment (University of Bristol Earth Sciences).

Dinosaur tracks by the billions have been discovered worldwide in over 1500 locations and like the nesting sites have been found sometimes in multiple layers at the same site (Lockley; 1991, Lockley *et al* 1995; Carpenter *et al*, 1994). Nest and egg sites, as well as fossil footprint sites, are always found on top of hundreds and even thousands of feet of strata. Clearly, many, many geologic events had already occurred in the areas where the eggs, nests, and footprints are found embedded within the local geologic record. In addition, a study of regional and structural geology shows most of these fossils were (or still are) covered over by yet more hundreds or even thousands of additional feet of strata!

Many creationists have acknowledged these numerous *in situ* fossils. A classic early paper on fossil nests and eggs was by Garner (1996). While the authors may take exception to the time element (post-Flood) given by Garner for these fossil evidences, the thrust of his paper remains convincing and strong. Garton (1996) has given an excellent paper on tracks of dinosaurs and of many other types of animals.

The Scriptural Account

The Genesis account of the Flood shows the Deluge was continuous and violent, the very opposite of tranquil conditions needed for nest site construction, egg-laying, incubation, and maturation of hatchlings:

> "…on that day all the fountains of the great deep were broken up, and the windows of heaven were opened. And the rain was on the earth forty days and forty nights…Now the flood was on the earth forty days. The waters increased and lifted up the ark, and it rose high above the earth. The waters prevailed and greatly increased on the earth, and the ark moved about on the surface of the waters. And the waters prevailed exceedingly on the earth, and all the high hills under the whole heaven were covered. The waters prevailed fifteen cubits upward, and the mountains were covered. And all flesh died that moved on the earth: birds and cattle and beasts and every creeping thing that creeps on the earth, and every man. All in whose nostrils was the breath of the spirit of life, all that was on the dry land died…Only Noah and those who were with him in the ark remained alive. And the waters prevailed on

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> the earth one hundred and fifty days (Genesis 7:11–12, 17–24, New KJV).

The Biblical picture of the Flood is horrendous in every aspect! The sky continually pours down torrential rains for 40 solid days. Huge water reserves under the earth are released. The waters continue to rise steadily until all the earth is covered with water. No land areas remain above water at the end of the 40 days.

That all the earth was covered by water by the end of the first 40 days of the Flood is very important. There simply is not enough time in the Flood for the events depicted by the eggs, nests, and footprints to occur. In addition, the waters prevail on the earth for 150 days. Indeed, that is the nature and purpose of the Flood—to destroy all air breathing life. Nothing in the biblical record suggests that the rain or the rising waters slackened at any time. Rather, the account stresses just the opposite: *"The waters prevailed and greatly increased on the earth...The waters prevailed exceeding on the earth...."* To suggest otherwise changes the Deluge into a more tranquil event than Scripture describes and creates embarrassing scenarios for creationists.

Analysis

While long million of years time intervals are not needed to explain the multiple nest site levels, their existence is still quite significant. The dinosaurs were able to return to the same area even after events had buried the previous nests. This set of circumstances indicates intermittent, local disturbances and does not fit an incessant, worldwide, violent Deluge as described in Genesis. The chaos of the Flood would not have afforded opportunity for building even *one* nest site layer along with time for incubation, hatching, and subsequent growth of the young. How could *multiple* nesting cycles possibly happen within the Genesis Flood Event?

Could the Flood have caused formation of all the underlying strata? If so, after the Flood deposited hundreds or even thousands of feet of fresh, wet strata, dinosaurs then built nests, laid and incubated eggs, watch them hatch and guarded the hatchlings while they grew—all while Flood waters were continually rising! While it is not known how long it took dinosaurs to incubate their eggs and, in some cases, for a hatchling to reach a length of 3.5 feet, clearly the short 40-day time span of the Flood excludes any possibility of it happening within the Flood.

The Bible makes it abundantly clear that at the end of 40 days the entire earth was already covered with water. The Deluge timeframe clearly does not "track" with the dinosaur nesting cycle. The Deluge was an event that destroyed and eroded large sections of what had been deposited by previous geologic activity. The destructive power of the Deluge can be clearly seen throughout the American southwest in prominent features such as buttes and mesas bearing stark testimony to the enormous erosion that took place. Vast areas of the landscape have been denuded of their once former extensive deposits.

And it is in such American West strata that many of the remains of dinosaur eggs, nest sites, and footprints are found in supreme abundance. This would seem to comprise compelling evidence that much geologic activity had already occurred during the long, pre-Flood cursed earth between Adam and Noah. This pre-Flood period had sufficient time to allow for burial of *in situ* time indicators of eggs, nests and tracks.

In addition, it must be remembered that while dinosaur tracks are limited to "Mesozoic" rocks, other animal tracks also appear in rocks from practically all the geologic "periods" of the "Paleozoic" and "Cenozoic" rocks. (The CCC young-earth, geologic model recognizes geological "Periods" as *ecologic* systems, not strict worldwide time periods as envisioned by the evolutionists.) The reader is urged to review this important aspect of the CCC model (Gentet, 2000).

References

CRSQ: Creation Research Society Quarterly
CENTJ: Creation Ex Nihilo Technical Journal

Carpenter, K., K. F. Hirsch, and J. R. Horner (editors). 1994. *Dinosaur eggs and babies.* Cambridge University Press, Cambridge.

———. 1999 . *Eggs, nests, and baby dinosaurs: A look at dinosaur reproduction (Life of the Past)*, Indiana University Press, Bloomington, IN.

Garton, M. 1996. The pattern of fossil tracks in the geological record, *CENTJ.* 10:82- 100.

Garner, P. 1996. Where is the Flood/post-Flood boundary? Implications of dinosaur nests in the Mesozoic. *CENTJ.* 10:101-106.

Gentet, R. E. 2000. The CCC model and its geologic implications. *CRSQ* 37:10-21.

Horner, J. R. 1979. Nest of juveniles provides evidence of family structure among dinosaurs. *Nature* 282:296-298.

———. 1982. Evidence of colonial nesting and 'site fidelity' among ornithischian dinosaurs. *Nature*, 297:675-676.

Horner, J. R., and James Gorman. 1988. *Digging dinosaurs.* Harper and Row, New York.

Lockley, Martin. 1991. *Tracking dinosaurs: A new look at an ancient world.* Cambridge University Press, Cambridge.

Lockley, Martin, and Adrian P. Hunt. 1995. *Dinosaur tracks and other fossil footprints of the Western United States.* Columbia University Press, New York.

University of Bristol Earth Sciences, http://www. palaeo.gly.bris.ac.uk/Palaeofiles/Eggs/Nests/ornnest.html

Zhenyu, Zhang. 2003. Which came first—the dinosaur or the egg? , http://www.bbc.co.uk/dinosaurs/dig_deeper/expert_article_8.shtml

Could Dinosaurs Make Tracks and Lay Eggs Early in the Flood?

Michael J. Oard*

There are hundreds of evolutionary/uniformitarian challenges aimed at creationists regarding the rocks, fossils, and the short time scale of Scripture. The Genesis Flood has been an integral part in providing plausible solutions to many of these challenges. Dinosaur tracks and eggs is just one of those challenges.

How to Meet Evolutionary/Uniformitarian Challenges

In order to provide plausible solutions for evolutionary/uniformitarian challenges, a creationist must first stick to Scripture and apply I Thess 5:21: "But examine everything carefully; hold fast to that which is good" (NASV). He must stick to the Bible and learn to not take every word from uniformitarian scientists as "the way it was." Secondly, he must learn all he can in a particular subfield of science related to the challenge, since these questions practically always lead one into specialties that he is not trained.

I have found during 30 years of research that reasonable answers to challenges can be found in many cases. One of the challenges that I have worked on is the claim of many repeating ice ages during the "late Pliocene and Pleistocene," each claimed to take 100,000 years. When one reads a popular book on the ice age, it appears that most of the uniformitarian data and the dates for the ice age agree and support their ice age theories. At first glance, their theory appears formidable. I applied the principles above, and examined the ice age carefully. By using the assumption of the Flood, in other words different initial conditions from the evolutionary/uniformitarian scientists, an ice age can occur rapidly and there does not need to be more than one (Oard, 1990). Another related challenge is pre-"Pleistocene" ice ages that supposedly occur several times as far back as 2 billion years. Based on gigantic landslides during the Flood, I believe that I have an adequate explanation for this challenge (Oard, 1997a). These are examples of what creationists can accomplish by holding their own. Creationists from all over the world are working on evolutionary/uniformitarian challenges by holding fast to the creation and the Flood (II Peter 3:3–6). These examples also show that we should never give up on a very key plank in the creationist paradigm when we meet evolutionary/uniformitarian challenges.

However, in our pursuit of challenges, we should not expect answers to come quickly or that every question, at least in this lifetime, can be answered. In these cases, we need patience and not jump to "solutions" when there are none. And we certainly should not give up on the Flood because we run into problems that we cannot immediately solve. We can always gather as much data on a particular problem with the hope that the next generation of creation scientists will arrive at a reasonable solution.

One of the first discoveries one makes in working on challenges is that the evolutionary/uniformitarian paradigm is not without its own serious and fatal challenges. Much data in biology and paleontology challenge the big picture of slow gradual evolution over millions of years. The gaps in the fossil record is a major challenge to their paradigm (Gish, 1995). Many geological formations are of fairly even thickness and cover tens of thousands to hundreds of thousand km^2 (Ager, 1973; Roth, 1998, pp. 218–219). A three dimensional analysis shows these layers are laid down in sheets. The horizontal strata of the top 1200 meters of Grand Canyon are a good example of sedimentary rocks covering a large area. The strata are composed of generally even layers that can be traced for over 320 kilometers in the canyon. They often extend well beyond the canyon (Austin, 1994). There does not seem to be any present processes, occurring on the bottom of the ocean that can cause such even layering over such distances. The Shinarump Conglomerate, considered a terrestrial deposit, is a widespread layer of sand and rounded rocks in the Colorado Plateau that is about 15 meters thick and covers more than 250,000 square kilometers (Brand, 1997, pp. 222–223). The conglomerate is rounded by the action of water. Today, there is no place on dry land that a uniform thickness of sand and gravel is being deposited by present processes (uniformitarianism) over a fairly level area anywhere near this size. It seems more likely that the sand and gravel was spread as a thin sheet by at least a regional scale cataclysmic flow of water. The uniformitarian radiometric dating system is quite challenging to creationists, but we are making good progress in meeting this challenge (Woodmorappe, 1999a; b; Vardiman, Snelling, and Chaffin, 2000). The evolutionary/uniformitarian problems make our alternative paradigm of creation and the Flood much more believable.

The Challenge of Dinosaur Eggs and Tracks

With this introduction, I come to the particular challenging problem of the millions of tracks and thousands of eggs recently discovered in sedimentary rocks over many parts of the world. Before we begin, we first need to place dinosaurs within the creation/Flood model.

According to the Bible, all terrestrial, air-breathing animals died by Day 150 in the Flood (Genesis 7:19–24).

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There is some debate over whether the Flood peaked at Day 40, Day 150, or in between, but it is safe to say that the maximum amount of time possible is 150 days, from whence the waters started to drain from the future continents. Since tracks and eggs are activities of live dinosaurs, there are only three possibilities: they are either pre-Flood, early Flood, or post-Flood. They cannot be late Flood because all air-breathing animals that lived on land died by then and dinosaurs very likely were terrestrial and certainly breathed air. Since tracks and eggs are often found on top of a few thousands meters of sedimentary rock, it is not likely they are pre-Flood, since these sedimentary rocks are Flood rocks. The post-Flood third option presents many difficulties, for instance how the dinosaurs managed to escape fossilization with large mammals and how they died in the post-Flood period (Oard, 1997b; 1998). Where I used to live in the dinosaur country of central Montana, evidence abounds that many hundreds of meters of sedimentary rock were at one time *above* the strata where dinosaur eggs are found (Oard, 1996). The same can be said for other areas on the high plains and the Rocky Mountains. So, the person who advocates that the dinosaurs are post-Flood is forced to believe the following great geological events after the Flood: 1) the dinosaurs were buried in sediments that cover many hundreds of thousands of km^2 in sediments that reach down hundreds of meters, 2) the sediment is somehow lithified, 3) the area is uplifted as the Rocky Mountains and high plains, 4) hundreds of meters of sediments was eroded from this huge area as a sheet forming large planation surfaces with capping quartzite boulders transported several hundred to perhaps a thousand kilometers, and 5) the last stage of erosion was channelized forming valleys (Klevberg and Oard, 1998; Oard and Klevberg, 1998).

So, the only reasonable choice is the second one, that the dinosaurs died early in the Flood. This time frame would correspond to the Inundatory Stage of the Flood according to Walker's (1994) biblical geological model. Critics charge that there is no way that dinosaurs could lay eggs and make tracks in the midst of a catastrophe as devastating as the early Flood, and that dinosaur tracks and eggs represent too much time for the 150 days of the early Flood. These critics also assume the mechanism and details of the Flood are known enough to claim that tracks and eggs could not be made.

So applying the two principles outlined in the introduction in meeting challenges, I examined the area where the dinosaurs are found in central Montana and southern Alberta, as well as read as much literature on the subject that I could find (Oard, 1995; 1997b; 1998). I first discovered that the evolutionary/uniformitarian story about dinosaurs has many holes, and there is much room for an alternative theory. There are still many unknowns associated with the dinosaur data, and that there are a number of misconceptions in the literature concerning the eggs and tracks. For instance, John Horner had once thought that the worn teeth found in dinosaur babies in central Montana were caused by the feeding of babies for a significant period of time by "good mothering lizards" (Horner, 1982). However, Horner and Phillip Curie later found embryos in dinosaur eggs that have worn teeth, leading to the conclusion that the dinosaur embryos ground their teeth *in the egg* (Horner and Currie, 1994). Horner and Dobb (1997, p. 153) point out:

> What about the worn teeth that we found first in the jaws of maiasaur nestlings, then in hypacrosaur embryos? It's now clear that dental wear is not evidence of parental care. My original interpretation turned out to be a misinterpretation...That leaves only one explanation: while inside their eggs, the embryos ground their diamond-shaped teeth together...

Worn teeth do not indicate a significant period of time as once thought.

The number of egg levels on Egg Mountain, Montana, is also questionable. It was stated by Horner (1982) that there were three levels, implying a nesting horizon similar to certain birds and a considerable amount of time between each horizon. Furthermore, some eggs are believed to have hatched, based on dead juveniles around the nests. This would be another indication of too much time having elapsed for the 150 days of the early Flood. However, the number of levels is questionable (Oard, 1998b, pp. 73–76). Furthermore, Horner misidentified an embryo in one of the eggs on "Egg Mountain," so the type of dinosaur that laid the eggs is *not* the same as the skeletons around the nest (Horner and Weishampel, 1996; Varricchio *et al*., 1997). This leads to the conclusion that these eggs likely never hatched, and that the juvenile skeletons in the egg-laying area moved into the area and died where other dinosaurs had just laid eggs. These events need not take much time. The same event can also repeat itself within the time of general rise in Flood waters. These two mistaken interpretations are listed in order to show the importance of using caution before jumping to unwarranted conclusions based on published data in the face of multiple unknowns.

When we examine tracks and eggs closer, we discover a number of puzzling features, if we assume they were made by normal dinosaur activity over long periods of time according to the evolutionary/uniformitarian belief. The tracks are always found on horizontal or nearly horizontal bedding planes (Lockley and Hunt, 1995). Why would the tracks not go from strata to strata? Were there not any hills to climb back then? Practically all individual dinosaur trackways (multiple tracks made by one dinosaur) are straight (going in one direction) (Lockley, 1994). Lockley and Hunt (1995, p. 165) write: "First, the sauropod was changing direction, turning to the right, a phenomenon *rarely* recorded in trackways" [emphasis mine]. Animals foraging for food, competing for mates, or other normal dinosaur activity commonly make curved, meandering, or sharply angled tracks. Straight tracks are usually made when an animal is fleeing something, such as a predator or hunter. I know, since one of my favorite pastimes is hunting elk in the snow. During the catastrophic onslaught of the Flood, we would expect dinosaurs to flee the encroaching Flood waters, making straight trackways (Oard, 2003)

It is unusual that there are very few tracks of babies and young juveniles (Lockley, 1991, pp. 31–32; Lockley and Hunt, 1995, pp. 121, 207). Modern track sites usually have a large percentage of baby and juvenile tracks. For instance, 50% of the elephant tracks in Amboseli National Park, Africa, were made by young elephants (Lockley, 1994, p. 359). There are very few tracks of dinosaurs that were most likely poor swimmers based on their morphology, such as stegosaurs, ankylosaurs, and ceratopsians (Lockley and Hunt, 1995, pp. 229, 231). None of these unusual characteristics of dinosaur tracks fit into the uniformitarian paradigm. The evidence better fits a time of worldwide stress for dinosaurs—a gigantic Flood.

Since the dinosaur tracks were made on hundreds of meters of previously-laid Flood sediments, they indicate a period when sediments or shallow shoals were briefly exposed as the water was rising (Oard, 1995). Track layers on more than one bedding plane in an area can be explained as representative of brief exposures during a generally, continuous sedimentation event. This implies local sea level oscillations with sedimentation continuing during the next transgression, explaining how the tracks were covered rapidly enough for them to be preserved. Oscillations in sea level would be expected during a global Flood caused by tides, local and distant tectonic events, and the dynamics of Flood currents (Barnett and Baumgardner, 1994). Barnette and Baumgardner (1994), using computer modeling, found that huge currents can be generated on shallow continents, just by the spin of the earth or the Coriolis force. In the troughs of these currents, they found the sea level would fall hundreds of meters and intersect the bottom. This pattern can remain stable for many days, leaving land in the middle of a trough exposed.

The Rocky Mountains and high plains have a large number of dinosaur fossils, large bonebeds, tracks and eggs. Hence one can surmise that this location represents a large Flood depositional basin that later became exposed or a series of shoals early in the Flood. The deposition would have the effect of *shallowing* the area, making it more vulnerable to later exposure. A local fall in sea level due to any of the mechanisms already mentioned would have provided enough land for the dinosaurs to embark. They would have laid eggs and made tracks on the exposed land. Numerous bonebeds in this area have many unusual features—ones that are indicative of a watery catastrophe.

This exposed land before Day 150 in the Flood could also explain the nature of the dinosaur eggs and the rare nests. It is natural to assume that many dinosaur females would be pregnant just before the Flood started. In a stressed condition they would lay their eggs and make nests on any temporary refuge they could find. A vivid illustration of this occurred in late February, 2000, in Mozambique (CNN news report, March 1, 2000). During a devastating flood, Cecilia Chirindza took refuge in a tree. As the flood surrounded her, she gave birth in the tree after three days of being stranded. Cecilia and the baby were rescued by a U.S. helicopter. When it was the baby's time, not even a flood could stop its birth.

The fact that very few nests are associated with the eggs indicates the eggs were laid in haste. They were often laid on simple bedding planes (Carpenter, Hirsch, and Horner, 1994). There are very few embryos associated with these eggs, also a possible indication of stressful conditions. Some of these eggs may have had time to hatch. The signs of hatching, however, such as eggs with broken tops, could have been caused by erosion when the next sedimentary layer was deposited, or compaction of the sediments, or the action of scavengers. There is evidence in egg laying areas and in bonebeds of scavengers, mainly in the form of carnivorous dinosaur teeth and teeth marks on bones. Scavengers would have been able to roam around on the exposed Flood sediments. All this dinosaur activity would have come to an end as the rising waters finally inundated the area and buried it under more sediments that were subsequently eroded during the Recessive Stage of the Flood (Walker, 1994).

Tracks and Eggs on Multiple Horizons

In the Flood with its rapidly oscillating sea level, it would be expected that the dinosaur activity would shift with each brief regression and transgression of the "exposed" sediments. This easily-visualized phenomenon could occur many times in one location and result in vertical layers of tracks and eggs. The most difficult example to explain is the alleged 300 dinosaur footprint horizons in South Korea. Unfortunately, there are only two substantive English-language publications on this subject (Lim *et al*., 1994; Paik *et al*., 2001), which makes a detailed examination of these claims difficult. However, it is easy to see, from the stratigraphic sections presented in the articles, that lithological character, lithological thicknesses, and stratigraphic intervals between dinosaur footprint horizons vary greatly over relatively short distances (few kilometers). This makes it difficult to evaluate how these horizons can supposedly be unambiguously correlated and, from this, how the 300-footprint horizon figure originated. In particular, does the field evidence *actually* require 300 successive events, or is it a composite of much fewer events occurring laterally in area and simultaneously in time (Woodmorappe, 2003, personal communication)?

The fact that there are relatively few footprints in total on these alleged 300 layers suggests a short amount of time for each set of footprints. Moreover, the fact that there are usually only a few to a few tens of centimeters of sediment between empirically-determined footprint horizons means that only small ebbings of Floodwaters would have been sufficient to bring in the sediment. The latter's thinness would have enabled the dinosaurs to simply keep stepping upward as the water kept flowing while progressively more sediment accumulated around their toes.

As it turns out, there are a number of observations relative to the Korean site which is inconsistent with the standard interpretation but consonant with a Flood one. The sauropod tracks are all of similar size, and from a young juvenile—very strange given the large amount of time allocated for deposition of these layers. Second, there is a preferred orientation of the dinosaur tracks, with some variability, that is *perpendicular* to the strongly preferred orientation of wave ripples. There should be lots of tracks parallel to the supposed lake, if it were a natural setting for dinosaurs along a lake, as suggested by evolutionary/uniformitarian scientists. Furthermore, we are asked to believe that, over so much supposed time, the subsidence of 110 meters of strata was taking place in exact balance to deposition. The evolutionary/uniformitarian scientists explain the strata as due to repeated flash floods into a lake. Somehow, there were no gullies formed during or after each postulated flash flood that is separated by a long period of time. Furthermore, why would such flash floods not destroy the footprints? The evidence better supports a sheet deposit laid down quickly by pulses of rising Floodwater with no time for extensive channelization. More information is needed to evaluate in more depth the "300 footprint horizon" claim than is available.

Summary

In summary, there are a number of unusual features of dinosaur tracks and eggs that are more indicative of a stressful environment than a natural environment. It is reasonable to believe that newly deposited sediments could become exposed for a short time early in the Flood due to events occurring within the Flood. Oscillations in sea level during a general rise in Flood waters are able to explain the eggs and tracks on multiple horizons. So, it is quite likely that all the dinosaur activity found in the sedimentary rocks did indeed happen during the first 150 days of the Genesis Flood.

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References

Ager, D.V., 1973. *The Nature of the Stratigraphic Record*. Macmillan, London.

Austin, S.A., 1994. Interpreting strata of Grand Canyon. In: Austin, S.A. (editor). *Grand Canyon—monument to catastrophism*. Institute for Creation Research, Santee, California, pp. 21–56.

Barnette, D.W. and J. R. Baumgardner. 1994. Patterns of ocean circulation over the continents during Noah's Flood. In: Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism*, pp. 77–86. Creation Science Fellowship, Pittsburgh, PA.

Brand, L. 1997. *Faith, reason, and earth history*. Andrews University Press, Berrien Springs, MI.

Carpenter, K., K. F. Hirsch, and J. R. Horner (editors). 1994. *Dinosaur eggs and babies*. Cambridge University Press, London.

Gish, D.T., 1995. *Evolution: The fossils still say no!* Institute for Creation Research, El Cajon, CA.

Horner, J.R. 1982. Evidence for colonial nesting and 'site fidelity' among ornithischian dinosaurs. *Nature* 297: 675–676.

Horner, J.R., and P. J. Currie. 1994. Embryonic and neonatal morphology and ontogeny of a new species of *Hypacrosaurus* (Ornithischia, Lambeosauridae) from Montana and Alberta. In: Carpenter, K., Hirsch, K.F., and Horner, J.R. (editors), *Dinosaur eggs and babies*, pp. 312–336. Cambridge University Press, London.

Horner, J.R., and E. Dobb. 1997. *Dinosaur Lives—Unearthing an evolutionary saga*. Harper Collins, New York.

Horner, J.R., and D. B. Weishampel. 1996. A comparative embryological study of two ornithischian dinosaurs. *Nature* 383:103.

Klevberg, P. and M. J. Oard. 1998. Paleohydrology of the Cypress Hills Formation and Flaxville gravel. In: Walsh, R.E. (editor), *Proceedings of the Fourth International Conference in Creationism*, pp. 361–378. Creation Science Fellowship, Pittsburgh, PA.

Lim, S.-K., (M. G. Lockley, S. N. Yang, P.S. Flemming, and K. Houck). 1994. A preliminary report on sauropod tracksites from the Cretaceous of Korea. *Gaia* 10:109–117.

Lockley, M. 1991. *Tracking dinosaurs—A new look at an ancient world*. Cambridge University Press, London.

_____. 1994. Dinosaur ontogeny and population structure: interpretations and speculations based on fossil footprints. In: Carpenter, K., K. F. Hirsch, and J. R. Horner (editors). *Dinosaur eggs and babies*, pp. 347–365. Cambridge University Press, London.

Lockley, M. , and A. P. Hunt. 1995. *Dinosaur tracks and other fossil footprints of the Western United States*. Columbia University Press, New York.

Oard, M.J. 1990. *An ice age caused by the Genesis Flood*. Institute for Creation Research, El Cajon, CA.

———. 1995. Polar dinosaurs and the Genesis Flood. *Creation Research Society Quarterly* 32:47–56.

———. 1996. Where is the Flood/post-Flood boundary in the rock record? *Creation Ex Nihilo Technical Journal* 10(2):258–278.

———. 1997a. *Ancient ice ages or gigantic submarine landslides?* Creation Research Society Monograph No. 6, Creation Research Society, St Joseph, MO.

———. 1997b. The extinction of the dinosaurs. *Creation Ex Nihilo Technical Journal* 11(2):137–154.

———. 1998. Dinosaurs in the Flood: a response. *Creation Ex Nihilo Technical Journal* 12(1):69–86.

———. 2003. In the footsteps of giants. *Creation* 25(2)10–12.

Oard, M.J., and P. Klevberg. 1998. A diluvial interpretation of the Cypress Hills Formation, Flaxville gravel, and related deposits. In: Walsh, R.E. (editor), *Proceedings of the Fourth International Conference in Creationism*, pp. 421–436. Creation Science Fellowship, Pittsburgh, PA.

Paik, I. S., H. J. Kim, and Y. I. Lee. 2001. Dinosaur track-bearing deposits in the Cretaceous Jindong Formation, Korea. *Cretaceous Research* 22:79–92.

Roth, A. A. 1998. *Origin—linking science and scripture*. Review and Herald Publishing, Hagerstown, MD.

Vardiman, L., A. A. Snelling, and E. F. Chaffin (editors). 2000. *Radioisotopes and the age of the earth: A young-earth creationist research initiative*. Institute for Creation Research and Creation Research Society, El Cajon, CA, and St. Joseph, MO.

Varricchio, D.J., F. Jackson, J. J. Borkowski, and J. R. Horner. 1997. Nest and egg clutches of the dinosaur *Troödon formosus* and the evolution of avian reproductive traits. *Nature* 385:247–250.

Walker, T. 1994. A biblical geological model. In: Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism*, pp. 581–592. Creation Science Fellowship, Pittsburgh, PA.

Woodmorappe, J. 1999a. *The mythology of modern dating methods*. Institute for Creation Research, El Cajon, CA.

———. 1999b. Radiometric geochronology reappraised. In: Woodmorappe, J., *Studies in flood geology – A compilation of research studies supporting creation and the flood*, pp. 145–175. Institute for Creation Research, El Cajon, CA.

Book Review

Shattering the Myths of Darwinism by Richard Milton
Park Street Press, Rochester, VT. 1997, 308 pp, $24.95

This book was reviewed in 1998 by Bergman (*CRSQ* 35(3): 171–172). Richard Milton is a British scientific journalist, who spend around 10 years doing research for the book. A first edition was published in 1992. Between the two editions Mr. Milton was vilified by the evolutionary establishment using the standard techniques of name calling and efforts at censorship. He received the most flack over the chapter on standard radiometric dating techniques. There he points out that it is possible for common lead 204 to capture two neutrons and become lead 206, which is also the end product of Uranium 238 decay. When this happens the two lead atoms can not be distinguished from each other by any analytical method. Hence the opportunity for error is great. At the end of this chapter Milton makes the following statement: "The fact is that presently it is impossible to say with any confidence how old the Earth is, beyond the obious fact that it predates the calendar of human history (p. 56)." There also is a good chapter on the limits of genetic variability in any population (Chapter 12).

At the end of the book Milton gives a summary of the Darwinian myths he has exposed: "There is the myth of radiometric dating; the myth of uniformitarian geology; the myth of a gradualist fossil record; the myth of beneficial mutations; the myth of natural selection; the myth that evolution is blind; the myth of the beak of the finch; the myth of the biogenetic law; the myth of vestigial organs; the myth of homology; the myth of the 'missing link' (p. 272)." This book, because of its readability, would be an excellent gift for a high school, college, or public library.

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Notes from the Panorama of Science

Using Care In Defining Evolution as Mere Change in Astronomy and Biology

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Some biologists as well as astronomers (Fix, 1999, p. 432) have defined evolution as mere change. Raven and Johnson (1989, p. 15) state: “The pattern of changes that result from [natural selection] is called evolution.” These authors more explicitly state elsewhere: “The ‘simple-to-complex’ levels of organization approach tends to obscure rather than illuminate evolutionary relationships” (Raven and Johnson, 1989, p. v). On the other hand, there are astronomers (e.g., Eddington, 1959, p. 56) as well as biologists (Huxley, 1955, p. 278) who have defined evolution, whether in astronomy or biology, as a process of change leading to some sort of higher complexity. There is no real difference in how the astronomical and biological communities think about what evolution means.

The evolutionary community, whether astronomical or biological, is ambivalent about how to talk about evolution. Sometimes it is “mere change,” but often it is “progress” (Henry, 2002, p. 217). There are cases in which an author in one place defines evolution as mere change, then elsewhere asserts that evolution means increasing complexity. Why this ambiguity? Because the evidence said to support evolution, whether biological or astronomical, shows no increase in system complexity, yet structural development must have occurred in both astronomical and biological systems if these began from a simple primordial state. This is also true in stellar evolution, for a star evolving out of a gas cloud would undergo an undisputed structural increase with resultant internal layers in formation at each stage of evolution, regardless of the change in entropy or “informational content” inherent in the system. Eddington insisted that an evolutionary increase in complexity applied not only to the cosmos in general (Eddington, 1930, pp. 11–22), but that this same phenomenon applied to stars, “the crucibles in which the lighter atoms... are compounded into more complex elements” (Eddington, 1920). To Eddington, stars at any time are experiencing a certain “stage of evolution”—not mere change of any sort—and a “scheme of evolution” which involves “progress” as “Nature builds stars” [his capitalization] (Eddington, 1929, pp. 106, 107, 114, 115). It is difficult to read “mere change” into Eddington’s words.

Thus the evolutionist desires to find a simple-to-complex progression and often defines evolution in this way, but without evidence for this, he is sometimes forced to fall back on “mere change” as evolution. This is a dodge to get around the lack of evidence for structural advancement. Indeed, biologist Jonathan Wells has observed, “When proponents of Darwin’s theory are responding to critics, they sometimes claim that ‘evolution’ means simply change over time. But this is clearly an evasion. No rational person denies the reality of change, and we did not need Charles Darwin to convince us of it. If ‘evolution’ meant only this, it would be utterly uncontroversial” (Wells, 2000, p. 5). This same “evasion” occurs as well in discussions of stellar and astronomical evolution in an attempt to make such processes seem “uncontroversial.” Eddington admitted that he could see only “catastrophic outbursts” which were a kind of “disease” in stars, but nevertheless spoke of the resulting change in mass as a kind of “evolution” (Eddington, 1929, pp. 120, 121), which in the light of his earlier comments he wanted to interpret as some kind of progress. Even biologists talk this way. Dobzhansky et al. (1977, pp. 6, 7) opine that “definitions of evolution that emphasize the transspecific aspect [i.e., upward species development] are... misleading,” and that, “A valid definition of evolution as a whole must not include the notion that evolution is always progressive.” But then these authors claim that evolutionary changes result in “greater complexity of developmental pattern” (Dobzhansky et al., 1977, p. 7).

Astronomy is rife with processes that cannot be understood except as structural decay, a fact long realized (Milne, 1931, pp. 715–716). Thus there is a strong tendency among astronomers to define evolution as mere change. We should not allow the evolutionary community to define decay as “evolution.” Deceptive definitions made for the purpose of saving evolutionism should be challenged, rather than tolerated and even defended.

Attempting to show that astronomical evolution (“mere change”) is supposedly different from that in biology (increasing complexity) is misleading. It is extremely doubtful that speciation leads to an increase in complexity at all, making biology as bankrupt in complexity-building processes as astronomy. Specific cases of speciation have been shown in fact to involve degradation (Wood, 2001, p. 3), leaving a “molecules-to-man” belief in evolutionary advancement altogether outside the realm of science. So-called primitive creatures (e.g., trilobites) are acknowledged by evolutionists to be as complex or more so than their modern counterparts (Coffin, 1983, pp. 231–232). Even more, a “transspecific continuum” is invoked for astronomical bodies, with Jovian-like planets commonly

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seen as "evolving stars" or "failed stars" (Thomsen, 1982, p. 424; Fix, 1999, p. 267; Goldsmith, 1985, p. 385), and with planets in turn having formed from asteroidal bodies (Rothman, 1985, pp. 119–120). This concept is not new (Iverach, 1894, pp. 5–6). With stars allegedly having evolved by this kind of astronomical "transmutation," the resemblance between evolutionary thinking in astronomy and biology would appear to be complete.

It is a dangerous position for a creationist to insist that stellar evolution is mere change. Such an approach would allow a hypothetical creationist teaching in a secular environment, for example, to speak of stellar decay as "evolution" like his evolutionary colleagues, yet in creationist settings, to invoke God as the director of such change. The secular world needs a more robust creationist witness than this. As important as a short chronology is for defending recent creation, the battle is more difficult if ground is needlessly given to the concept of astronomical evolution.

Care must also be exercised in evaluating other claims in astronomy:

1. The assertion that because the laws of physics are valid, evolutionary solar/stellar models must be valid. This is an unjustifiable claim most often made implicitly (e.g., Harwit, 1982, pp. 306–343; Abell et al., 1987, pp. 506–509). This is an appeal to the laws of physics to justify an uncritical acceptance of conventional solar/stellar operation. However, rejecting such an appeal is not equal to rejecting concepts such as solar fusion and neutrino production. This appeal is invalid because physical laws have limited application, valid for some systems but not others. The misapplication of a valid law makes an invalid model. Though we know the laws describing the atmosphere, applying these laws accurately in weather forecasting is difficult, which is why weather forecasts are only approximately correct.

Justifying solar/stellar models by the validity of the laws behind them is like the fallacious argument for geological uniformitarianism. This argument claims that since the laws of physics and nature are uniform and do not change, it follows that natural processes are uniformitarian. Levin (1986, p. 175) argues, "Uniformitarianism is often paraphrased as 'the present is the key to the past.' Thus, geologic features formed long ago were produced by processes that are still at work today. . . . It is not conditions on earth which have been uniform, but rather it is the physical and chemical laws that govern geologic processes." But the term "uniformitarianism" applies only to the processes described by the laws, not to the laws themselves. Levin's fallacious definition of uniformitarianism mirrors the assertion of some astronomers that the laws of physics justify acceptance of conventional solar/stellar models. Neither in geology or astronomy does the use of valid laws guarantee a valid model.

It is a dangerous position for creationists to insist that the laws of physics justify any conventional solar/stellar model(s). Such an approach would allow a creationist teaching in a secular environment, for example, to accept possibly flawed solar/stellar models along with his evolutionary colleagues, while invoking God in creationist settings as the sustainer of model processes. Such a outcome would mimic the failed approaches of theistic evolutionists in promoting their evolutionary models.

2. The implicit assertion that one cannot legitimately critique conventional solar/stellar models without extraordinary proof. This echoes the evolutionary claim that these models are beyond reasonable doubt. This assertion is implicit in any facile assumption that certain solar phenomena (fusion and neutrino production) occur as believed by the evolutionary community. A reader would likely conclude that the models are beyond questioning.

The "best-in-field fallacy" claims that majority beliefs must be unquestioned unless they are replaced with one of equal or superior "elegance" or "complexity" (MacBeth, 1978, p. 78), a justification shown above to be invalid. To avoid committing the same fallacy, some astronomers may claim that one must demonstrate that the laws of physics will not work as required in conventional models. This is tantamount to requiring proof that none of the phenomena claimed in conventional solar/stellar evolution is occurring. Questioning some aspects of conventional solar/stellar models is not tantamount, say, to denying that fusion reactions occur in the sun. To make such a claim is an evident attempt to stymie any legitimate critique.

Contrary to such an extraordinary standard of disproof of conventional models, invalidation of any model requires only one contradiction. Despite the highly publicized SNO (Sudbury Neutrino Observatory) results claiming to have resolved the SNP (solar neutrino problem) (Seife, 2001, pp. 2227–2228), problems in other solar disciplines such as helioseismology have not been resolved by the SNO results. The SNP was only one of the problems for the conventional model, and reportedly solving it has not answered the other problems. There continues to exist a valid basis for questioning conventional solar/stellar models.

It is a dangerous position for a creationist to insist that conventional solar/stellar models are so certain that the sun would "evolve" if there were time. Imagine the ease with which a creationist could slip into a secular teaching assignment, refraining to mention only the "age issue" which he feels is the one barrier between him and his evolutionary colleagues, while maintaining in creationist settings that the sun would not "really" evolve—but only because there is insufficient time, not because of any inherent impossibility. Could any questioning student be mislead by such an approach, eventually accepting evolution because of the muted creationist message? The secular world needs a probing critique of evolutionary models which will generate discomfort, rather than accommodation, with evolutionary assertions.

3. The assertion that "creationist" proposals of planetary accretion are inherently non-evolutionary. This generally is the claim of theistic evolutionists, that by invoking the name of God they are "creationists," not evolutionists.

If planetary formation is discussed in a recent creation framework, why use a term loaded with evolutionary connotations? Admittedly, creationists use other evolutionary-laden terms (e.g., in biology, protozoa; in geology, archeozoic and mesozoic), but why seek to press another such term into creationist use? Through the years there have been creationist proposals for replacing evolutionary terms, a necessary innovation which would take attention away from naturalistic processes.

A deeper problem with terms like "accretion" for Creation Week events is that they connote a physical process, no matter how brief or how divinely directed, whereas the Bible teaches, through the use of words like *bara*, that the creation was a sequence of instantaneous events inexplicable by any modification of present-day natural law. Invoking a mechanism understandable in evolutionary terms, and with evolutionary connotations, but "directed" by God—how is this so different from the approach of progressive creationists and other accommodationists? It is a dangerous position for a creationist to insist on using evolutionary terms and mechanisms as if they are legitimately adaptable to biblical creation.

4. The implicit assertion that stars have an in-built capacity for present-day "replication." This echoes the evolutionary assertion that some mechanisms, not yet elucidated, cause stars to form today.

A straightforward reading of Scripture suggests that there is no star formation now. Stars were made on Day Four of the Creation Week (Genesis 1:16). Further, they were created by the "word of the Lord" (Psalm 33:6), a condition applying to no star hypothetically forming today. Finally, the creation was finished at the end of the sixth day (Genesis 2:1).

Creationist astronomers such as Faulkner have acknowledged that star formation today is virtually impossible (Faulkner, 2001, p. 43), and that, "I do not think that this problem [of stellar evolution] is solvable." Where does the belief come from that stars are now forming? I would suggest that rather than practicing exegesis to justify current star formation, the evolutionary thinking swamping our culture has spawned an eisegesis which is the ultimate source of such assertions. All creationist astronomers should rule out present-day star formation.

Indeed, the attempt can be made to rationalize present day star-formation by appealing to biology: "God created humans during the Creation Week, but new humans are born all the time. This fact does not violate God's declaration that he has ceased creating. Instead, we recognize that only humans can beget humans today." The conclusion is supposed to be that stars are also "born" today. However, humans reproduce because God designed in each human a genetic code. There is no corresponding "code" in nebulae or stars.

The points refuted above provide a blueprint whereby a future creationist could comfortably straddle both the secular and creationist communities, teaching in concordance with evolutionary concepts on one hand (perhaps with mental reservations), but on the other hand gaining the respect of creationists because of his secular position. Such a blueprint will not produce a creationist astronomy. It is a recipe for accommodationism.

References

CRSQ: Creation Research Society Quarterly

Abell, G.O., D. Morrison, and S.C. Wolfe. 1987. *Exploration of the universe*. Saunders, Philadelphia.

Bahcall, J.N. 1989. *Neutrino astrophysics*. Cambridge University, New York.

Coffin, H.G. 1983. *Origin by design*. Review and Herald, Washington.

Dobzhansky, T., F.J. Ayala, G.L. Stebbins, and J.M. Valentine. 1977. *Evolution*. Freeman, San Francisco.

Eddington, A.S. 1920. The internal constitution of the stars. *Nature*. 106:14. http://cosmos.colorado.edu/astr1120/eddington .html

Eddington, A.S. 1929. *Stars and atoms*. Yale University, New Haven.

Eddington, A.S. 1930. *Science and the unseen world*. Macmillan, New York.

Eddington, A.S. 1959. *New pathways in science*. University of Michigan, Ann Arbor.

Faulkner, D. 2001. Does the collapse of a gas cloud to form a star violate the second law of thermodynamics? *CRSQ*. 18(1):40–44.

Fix, J. 1999. *Astronomy*. WCB/McGraw-Hill, Boston.

Goldsmith, D. 1985. *The evolving universe*. Benjamin Cummings, Menlo Park, CA.

Harwit, M. 1982. *Astrophysical concepts*. Concepts, Ithaca, NY.

Henry, J. 2002. Star formation: natural or supernatural? *CRSQ*. 38(4):217–220.

Iverach, James. 1894. *Christianity and evolution*. Thomas Whittaker, New York.

Levin, H. 1986. *Contemporary physical geology*. Saunders, Philadelphia.

MacBeth, N. 1978. *Darwin retried*. Gambit, Ipswich, MA.

Milne, E.A. 1931. Contributions to a British Association discussion on the evolution of the universe. *Nature*. 128 (supplement):715–716.

Raven, P.H., and G.B. Johnson. 1989. *Biology*. Mosby, St. Louis.
Rothman, T. 1985. *Frontiers of modern physics*. Dover, New York.
Seife, C. 2001. Polymorphous particles solve solar mystery. *Science*. 292:2227–2228.
Thomsen, D.E. 1982. Seeking the planets of other stars. *Science News*. 121(26):424.
Wells, J. 2000. *Icons of evolution*. Regnery, Washington.
Wood, T.D. 2001. Genome decay in the mycoplasmas. *Impact*. No. 340. Institute for Creation Research, El Cajon, CA.

Swim in an Aquarium: The Jetties at St. Andrews State Park, Florida

Carl R. Froede Jr.*

For many individuals, the examination of undersea life is typically limited to aquariums and glass-bottom boats, unless one is willing to take the time, expense, and effort to rent a boat and proceed to an offshore wreck or travel to places like the Florida Keys. I want to share a little known area in the Panhandle of Florida where anyone can observe literally thousands of fish and assorted marine life in three to 12 feet of water. I have snorkeled at this location for almost 30 years and have found it to be one of the best places outside of the Florida Keys to observe a variety of marine life. This place is the jetties at St. Andrews State Park located on the eastern side of Panama City Beach, Florida.

The Rock Jetties of St. Andrews State Park, Florida

Access from the Gulf of Mexico to St. Andrew Bay (Figure 1) is through a channel that is maintained by large blocks of rock, commonly identified as riprap (Figure 2). Underwater, these blocks serve as a haven for a large variety of marine life (Plate 1). All of this sea life is readily accessible and easily observable to anyone wearing a swim mask. The State of Florida has recently passed a law requiring SCUBA divers and snorkelers to display a "Divers Down" flag while participating in underwater activities throughout the State. However, the Park staff has informed me that a "Divers Down" flag is not required at the St. Andrews or Shell Island lagoons (Figure 1). This makes observation of marine life along the jetties simple and unencumbered.

The best time to observe marine life is two to three hours before high tide, a once a day event at this locale. Water visibility can be up to 50 feet. Visibility sharply decreases to 10 to 15 feet when the tide is low or receding. Consult a newspaper or website to identify the time when high tide will occur. I have found that if high tide occurs around midday and you arrive at the jetties when the Park opens (8:00 am, Central Time) that sea life is most diverse. Rare marine life returns to the shadows under the rocks with the rising of the sun and increased snorkelers in the area. A list and description of all the sea creatures that I have observed at the jetties would likely fill several pages!

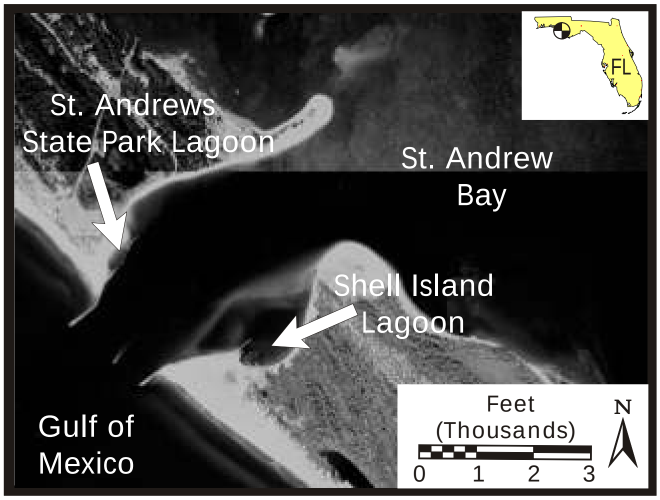

Figure 1. Aerial photograph showing the outlet from St. Andrew Bay to the Gulf of Mexico. The entrance to the Gulf of Mexico is lined by riprap. These rocks form an excellent setting for a variety of marine life found at both the St. Andrews State Park and Shell Island lagoons. Photograph courtesy of the United States Geological Survey.

For those individuals who worry about sharks, I have never observed any in all the years that I have been diving the jetties. I have seen one four-foot-long barracuda, but they are not as dangerous as their reputation. The most "dangerous" creatures that I have found are the spiny sea urchins and stinging jellyfish. As long as one is careful, these creatures will not pose any problems.

Marine life is much more colorful than any found in freshwater. Snorkeling on a bright sunny day will easily reveal the beautiful colors of God's wonderful creation. As the water depth never exceeds 12 to 14 feet, you will not notice a loss of red/orange/yellow color—a concern for SCUBA divers who swim deeper than this light penetrates.[1] Marine biologists are well aware of the many useful

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[1] Editor's Note: Marine biologists . . . clear in nature. Marshall, Justin. 2002. Why are reef fish so colorful? *The Oceans Scientific American Quarterly* 9:54–57.

functions various colors and color schemes are playing in the lives of fish (Marshall, 2002). Colorful eye-like dots on both ends of certain fish serve to confuse would-be predators as to which end is the tail and which is the head. Some very bright colors can be used by fish as "displays" to potential mates or rivals during courtship. Certain highly poisonous fish have startlingly bright colors that put their pursuers "on notice." There are few places that compare with a SCUBA venture as opportunities to see how the Creator has made His purposes clear in nature (Marshall, Justin. 2002. Why are reef fish so colorful? *The Oceans Scientific American Quarterly* 9-54-57).

Snorkeling equipment (i.e., mask, snorkel, and fins) can be rented at the Park so not having equipment is never an excuse. However, purchasing a dive mask is preferable as this is the most important piece of your equipment and you don't want a leaking mask to ruin your diving experience. Having an inexpensive disposable underwater camera (the type found at K-Mart or Wal-Mart) will allow you to capture on film the sea life observed while swimming among the schools of fish along the submerged blocks of rock. An underwater camera is one of the most exciting tools to have when snorkeling the jetties and a recommended asset for preserving your experience for fond remembrances. Observe the focal length of the camera or you will have pictures that are out of focus because you can get too close to your subjects!

Conclusion

If you are planning to be in the Panama City Beach area, I strongly encourage you to consider snorkeling the jetties at the St. Andrews Park lagoon. It truly is some of the easiest and best shallow water marine snorkeling and diving that I have experienced. You will come away from this place with a greater appreciation of God's undersea creation.

Acknowledgments

I am grateful for my wife's continuing support of my research and writing. Mr. Jerry Akridge kindly reviewed a draft of this article. However, any mistakes are my own. To God be all the glory. Proverbs 3:5–6.

Plate 1. Images from the St. Andrews State Park lagoon.

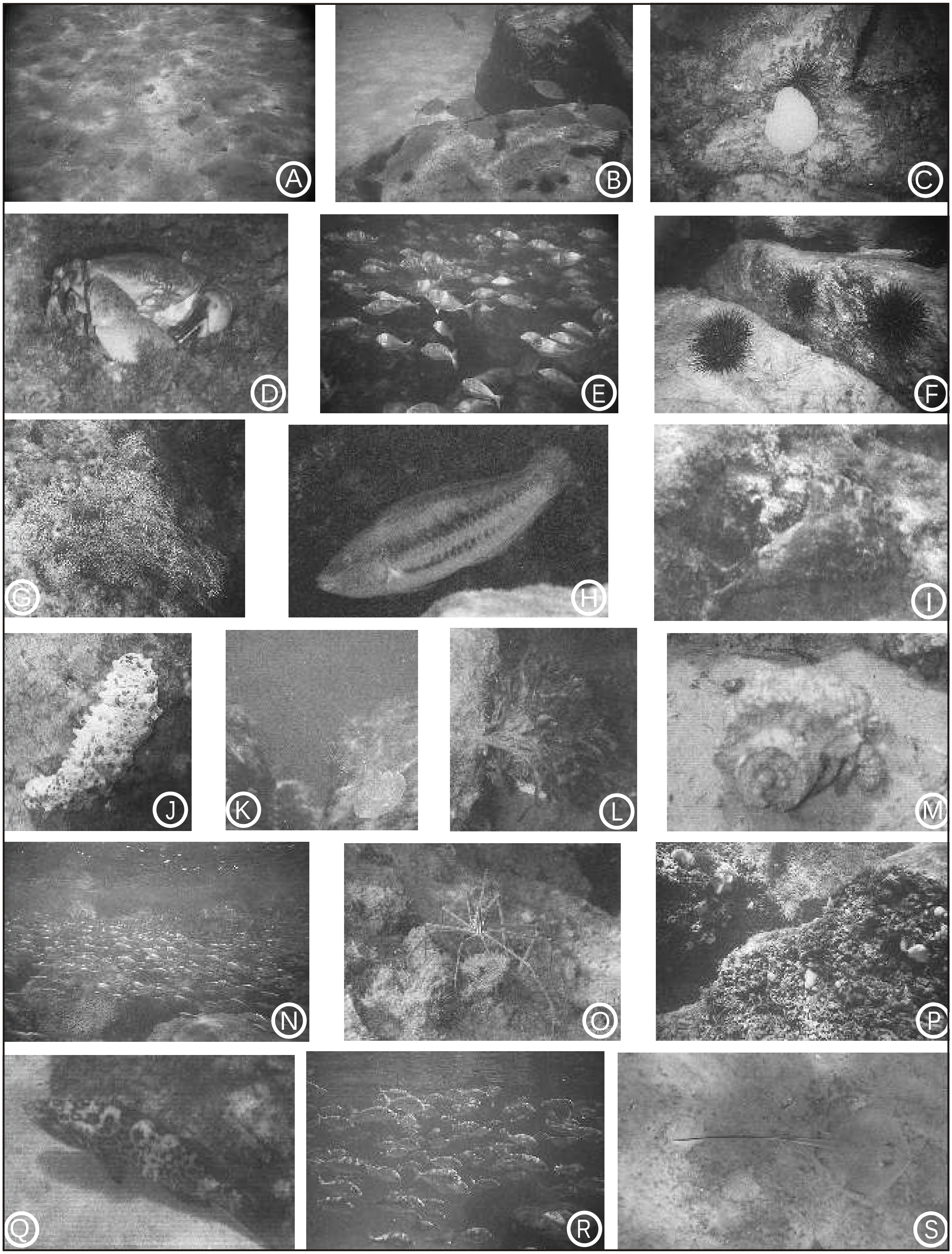
A. In many places, the bottom of the lagoon is highly bioturbated by worms and crustaceans.
B. Large fish swim among the blocks of rock that form the jetties.
C. A spiny sea urchin lies adjacent to a grapefruit-sized coral head.
D. A large crab lies on an algae-covered block.
E. A school of Bluestriped Grunts swims close enough to touch.
F. Spiny sea urchins can be found it many areas covering the rocks.
G. A feathered hydroid.
H. A 12-inch-long wrasse.
I. An 8-inch-long sea slug.
J. A 12-inch-long sea cucumber.
K. A stinging jellyfish.
L. An algae plant.
M. A large hermit crab.
N. A large school of small fish—thousands swim along the jetties.
O. An arrow crab.
P. Algae and small heads of coral cover the submerged blocks of rock supplying both habitat and food for a large variety of creatures that consider the jetties home.
Q. A 12-inch-long grouper.
R. Another school of Bluestriped Grunts.
S. A small stingray swims along the bottom adjacent to the jetties.

Variation within the Kinds but Fixity of the Kinds

Frank L. Marsh

The scientist reads in Genesis of the fiat creation and instantaneous appearance in the beginning, of basic types of plants and animals which were made and which reproduced according to a certain fixity. The book of nature, through its fossil record and in the world of living things, reveals that an actual fixity has ever existed and still does exist among these forms. The fixity is not one which produced identical individuals, but rather is one which produces physiologically isolated groups which enjoy considerable variation within their boundaries. These original groups demonstrate that they have no power to produce any new basic types. In this complete verification in nature of the assertions of Genesis, the Christian man of science receives added assurance that the Bible is indeed a book breathed by the God of Truth.

From: Marsh, Frank L. 1964. The Genesis kinds in the modern world. *CRSQ* 1:30-37. This volume and all others of the *CRSQ* are now available in printed and electronic form. An order form is at the end of this issue.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Minutes of the 2003 Creation Research Society Board of Directors Meeting

On Thursday, 29 May 2003 a meeting of the Board of Directors (BOD) was held at the Four Seasons Sheraton Hotel, Milwaukee, Wisconsin, from 1900 hours to 2100 hours to plan for the committee meetings on Friday. On Friday, 30 May 2003 between the hours of 0830 and 1700 the Finance, Membership, Research, VACRC, Internet Constitution/Bylaws/Advanced Planning, RATE, Quarterly and Publication Committees each met separately for approximately two hours to plan for the Saturday business meeting.

On Saturday, 31 May 2003 the closed business meeting of the BOD was called to order at 0830 hours, Present: K. Anderson, T. Aufdemberge, E. Chaffin, D. DeYoung, W. Frair, R. Gentet, H. Giesecke, D. Gish, G. Howe, R. Humphreys, D. Kaufmann, L. Lester, G. Locklair, J. Meyer, M. Oard, E. Williams, G. Wolfrom. Absent: J. Reed, R. Samec.

After a devotion by John Meyer, the minutes of the 2002 BOD meeting were accepted as distributed prior to the meeting.

Recording Secretary Kaufmann reported that the following were elected to a three year term to the BOD: K. Anderson, E. Chaffin, L. Lester, J. Reed and G. Wolfrom.

The Treasurer's report by Gentet was presented and accepted. A budget for 2003 of $333,850 income and $325,250 outgo was accepted.

The finance committee report by Aufdemberge resulted in the following actions: it was passed to set the pay scale for CRS secretarial staff at $15.00 per hour. VACRC had already passed this pay scale for the Center's secretary. It was also passed to approve the addition of Ray Lawhead's name to be put on the signature card for the publication operations account at VACRC, and that he be issued a debit card.

The membership report by Wolfrom was given as follows: total membership for 2002/03 was 1694 (660 voting, 689 sustaining, 334 subscriber and 11 students). This is an increase of 30 from the 2001/02 membership year.

The membership committee report by Kaufmann resulted in the following actions: it was passed to set up an Ad Hoc Committee of Giesecke, Wolfrom, Oard and DeYoung to devise a plan to centralize the receipt and processing of funds for memberships, donations, and sales of publications at our facilities in Chino Valley, Arizona. It was passed to utilize our hospitality hour at the 2003 International Conference on Creation (ICC) at Geneva College, Beaver Falls, Pennsylvania, as a membership effort with each registrant receiving a welcome letter, a free copy of the *CRSQ* and a special membership offer to join the CRS.

Chaffin reported for the research committee that about ten principal investigators, some of whom have more than one project, are currently involved in projects supported by the research fund. One new project was approved by the committee during the meeting, and it was passed to take $5000 from the 2003 research fund budget and transfer it to the VACRC 2003 budget to cover various expenses.

The lab committee report by DeYoung resulted in the following action: it was passed that CRS pursue purchase of the 2.5 acres of land adjacent to the VACRC site. This offer is subject to tax implications and a negotiated offer to be approved by the executive committee. This lab expansion is to be financed from the research fund. It was also passed that as of 1 Aug 2003 Meyer will go to a halftime position at VACRC.

The internet committee report by Locklair noted that our website receives about 500,000 hits per month. It was passed to provide a gift of $250 to our Webmaster, Fred Williams in appreciation for his services.

The constitution committee report by Kaufmann resulted in the following action: in order to promote cordial cooperation with Answers in Genesis (AIG), the CRS will offer to provide to AIG's museum the following interactive displays: Speaking Things into Existence (by Locklair), Stardust Observatory (by Meyer) and a botanical display (by Howe).

The RATE committee report by Humphreys stated that various research papers by the RATE committee will be presented at the 2003 ICC conference at Geneva College, Beaver Falls, Pennsylvania.

The quarterly committee report by Lester resulted in the following action: it was passed to appoint K. Anderson as *CRSQ* Editor-elect for 2003/2004.

The *Creation Matters* report by Wolfrom stated that the bimonthly publication is now in its eighth year. For continued publication, a steady stream of articles is required.

The publication committee report by Oard stated that two books are presently in press.

It was passed to nominate the following for the BOD election in 2004: DeYoung, Humphreys, Kaufmann, Locklair and Samec.

The following officers were elected for 2003/2004: President, D. DeYoung; Vice President, E. Chaffin; Recording Secretary, D. Kaufmann; Treasurer, R. Gentet; Membership Secretary, G. Wolfrom; Financial Secretary, T. Aufdemberge.

It was passed to hold the 2004 BOD meeting at Phoenix, Arizona, on Thursday June 3 to Saturday, June 5.

The meeting was adjourned at 1500 hours.

Respectfully submitted,
David A. Kaufmann, Recording Secretary

Creation Research Society
Membership/Subscription Application and Renewal Form

The membership/subscription categories are defined below:

1. Voting Member	Those having at least an earned master's degree in a recognized area of science.
2. Sustaining Member	Those without an advanced degree in science, but who are interested in and support the work of the Society.
3. Student Member	Those who are enrolled full time in high school or undergraduate college.
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7. Subscriber	Libraries, churches, schools, etc., and individuals who do not subscribe to the Statement of Belief.

All members (categories 1–6 above) must subscribe to the Statement of Belief as defined on the next page.

Please complete the lower portion of this form, and mail it with payment to the membership secretary:

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Creation Research Society

History—The Creation Research Society was organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (graduate degrees in science) and about 1000 nonvoting members. The *Creation Research Society Quarterly* has been gradually enlarged and improved and now is recognized as the outstanding publication in the field. In 1996 the *CRSQ* was joined by the newsletter *Creation Matters* as a source of information of interest to creationists.

Activities—The society is solely a research and publication society. It does not hold meetings or engage in other promotional activities, and has no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund is maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible. As part of its vigorous research and field study programs, the Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

Membership—Voting membership is limited to scientists who have at least an earned graduate degree in a natural or applied science and subscribe to the Statement of Belief. Sustaining membership is available for those who do not meet the academic criterion for voting membership, but do subscribe to the Statement of Belief.

Statement of Belief—Members of the Creation Research Society, which include research scientists representing various fields of scientific inquiry, are committed to full belief in the Biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution) both of the universe and the earth with its complexity of living forms. We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. All members of the Society subscribe to the following statement of belief:

1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.
2. All basic types of living things, including humans, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.
3. The Great Flood described in Genesis, commonly referred to as the Noachian Flood, was a historical event worldwide in its extent and effect.
4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and Savior. The act of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Savior for all people. Therefore, salvation can come only through accepting Jesus Christ as our Savior.

Instructions for Authors

Submission

Three paper copies and a computer file shall be submitted to the editor of the *Quarterly*. Each copy should have a title page with *only* the title, author contact information, and a list of key words for subjects covered in their articles. The second page should have the title, no author information, and the rest of the article to allow anonymous reviewing.

Authors must realize that the editors will subject their papers to changes as necessary, in order to make them more suitable for the broad spectrum of *CRSQ* readers. If the revisions of the editor and referees are extensive, the changes will be sent to the author to be incorporated in the final draft. If the changes are not acceptable to the author, he may withdraw his request for publication, or he may request that the changes be examined by another editor, whose decision will be final.

All submitted articles will be reviewed by at least two technical referees. The editor may or may not follow the advice of these reviewers,and the author may defend his position against referee opinion. After the peer review is finished and all changes have been made to the article, a final paper copy and computer file will be requested. Authors who provide either an email address or fax number will receive a copy of their article just prior to publication. Materials will not be returned to authors unless accompanied by a self-addressed, stamped envelope.

The *Quarterly* is a journal of original writings. Only under unusual circumstances will we reprint previously published manuscripts. Never submit an article to two or three journals, including ours, hoping all of them will publish your work. When submitting an article, please state if the material has been published previously or has been submitted to other journals.

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Manuscripts shall be computer-printed (or typed) and double-spaced. If you are unable to provide a copy of your paper on computer disk, one final paper copy should have no handwritten marks of any kind in the text area, although you may write page numbers at the bottom of each page.

Although it is nicer to be positive, there seem to be a lot of important negatives:

- Do not indent the first word of each paragraph; separate paragraphs by an extra blank line instead.
- Never press the space bar more than once *anywhere*, not even at the ends of sentences.
- Do not split words with hyphens at the ends of lines.
- Do not use all capital letters for *anything* (titles, etc.).
- Do not use bold type in the paragraphs; use italics to call attention to words.
- Do not use multiple spaces for tables and similar material. Use tabs instead.
- Do not use dashes (—) for definitions, but use colons instead, e.g., "NR: Not recorded." Where dashes are appropriate, to indicate a pause in thought, please use *two hyphens* (with no spaces on either side) if your word processor does not offer an actual dash.

Each footnote should be included *in the text*, surrounded by [brackets], immediately after the text to which the footnote applies.

All figures and drawings must be of high quality, therefore, no sloppy drawings or lettering will be accepted. Use patterns, rather than shading, in line drawings. Unacceptable illustrations will result in rejection of the manuscript for publication. Do not embed pictures in text files.

References and Book Reviews

References should be in the current *Quarterly* style. Additional references with *identical* authorship should be preceded by three underline characters in place of the name(s). Note the use of commas and periods in the examples below.

CRSQ: Creation Research Society Quarterly. [for multiple *Quarterly* references]

Cockman, Joneen. 1988. Collecting plants for the Creation Research Society Herbarium. *CRSQ* 24:187–193.

Margulis, Lynn. 1971a. The origin of plant and animal cells. *American Scientist* 59:230–235.

———. 1971b. *Origin of eukaryotic cells*. Yale University Press, New Haven, CT.

Hitchcock, A. S. 1971. *Manual of grasses of the United States*. Dover Publications, New York.

Walker, Tasman B. 1994. A biblical geologic model. In Walsh, R.E. (editor), *Proceedings of the third International Conference on Creationism* (technical symposium sessions), pp. 581–592. Creation Science Fellowship, Pittsburgh, PA.

Book review headings, like references, have a particular style which should be followed. This issue of the *Quarterly* will provide examples.

Length

Manuscripts containing more than 25 pages are discouraged. If a topic cannot be covered to the author's satisfaction in this number of pages, the author should divide his material into separate papers that can be serialized in the *Quarterly*. Book reviews should be limited to 1000 words.